WESTCARB Phase I Results Summary

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Regional Partnership Review Meeting
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Outline

- **Phase I overview**
- Geologic characterization studies
- Defining best geologic options
- Terrestrial baselines and opportunities

Who Is WESTCARB?

- Researchers from 70 organizations comprising:
  - Resource management and environmental protection agencies
  - National laboratories and research institutions
  - Conservation nonprofits and climate registries
  - Oil and gas companies
  - Power companies
  - Pipeline companies
  - Colleges and universities
  - Trade associations and policy coordinating bodies
  - Vendors and service firms
  - Consultants
- Led by California Energy Commission







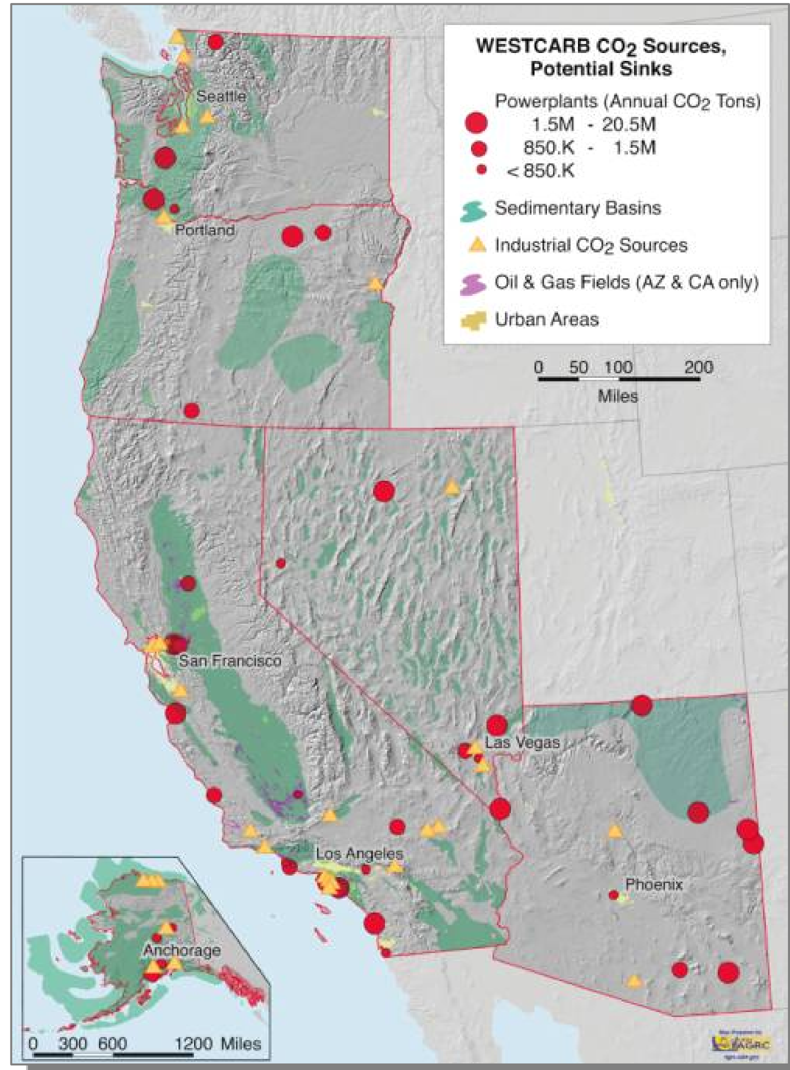


Phase I Accomplishments

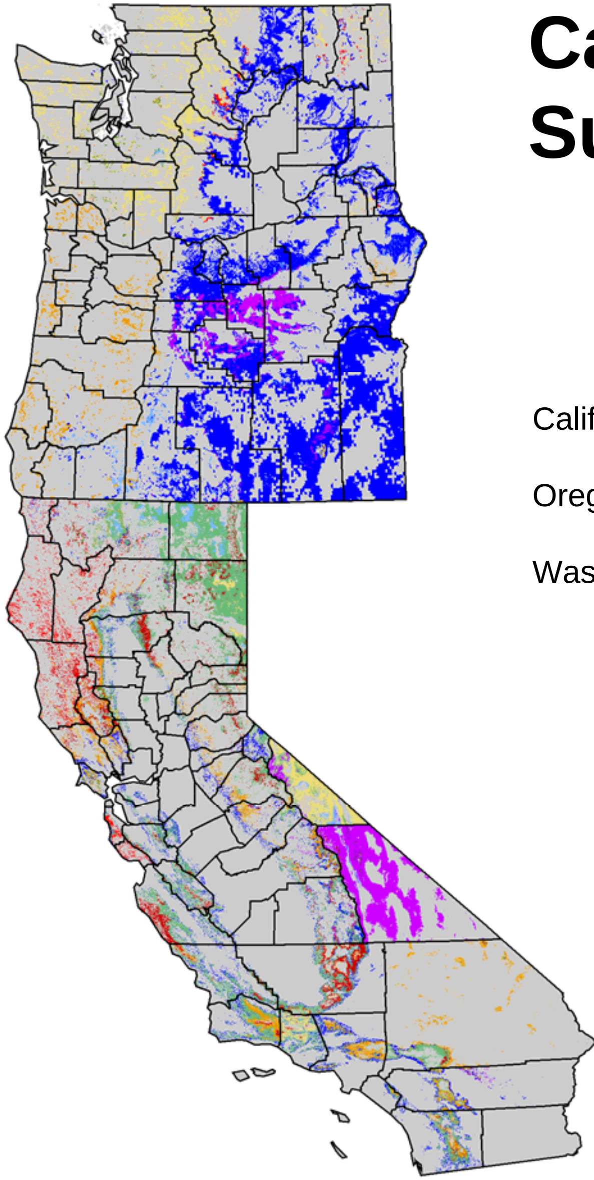
- Centralized GIS source and sink database
- Major point sources and geologic sinks identified and characterized
- Geologic and terrestrial storage estimates made for major sinks
- GIS-based method for source-sink matching implemented; marginal cost curves developed
- Terrestrial baselines and supply curves developed
- Current regulatory structure outlined
- Heightened awareness of sequestration among state, community, and industry leaders
- New approach for screening and ranking sequestration sites

Point Sources in Proximity of Broadly Distributed Sedimentary Basins

- Characterized sources account for about 80% of total industrial and utility sector emissions
- Sedimentary basins defined; geologic and oil and gas field data assembled
- Data reside at Utah AGRC, publicly accessible, part of national database



Carbon Sequestration on Suitable Rangelands



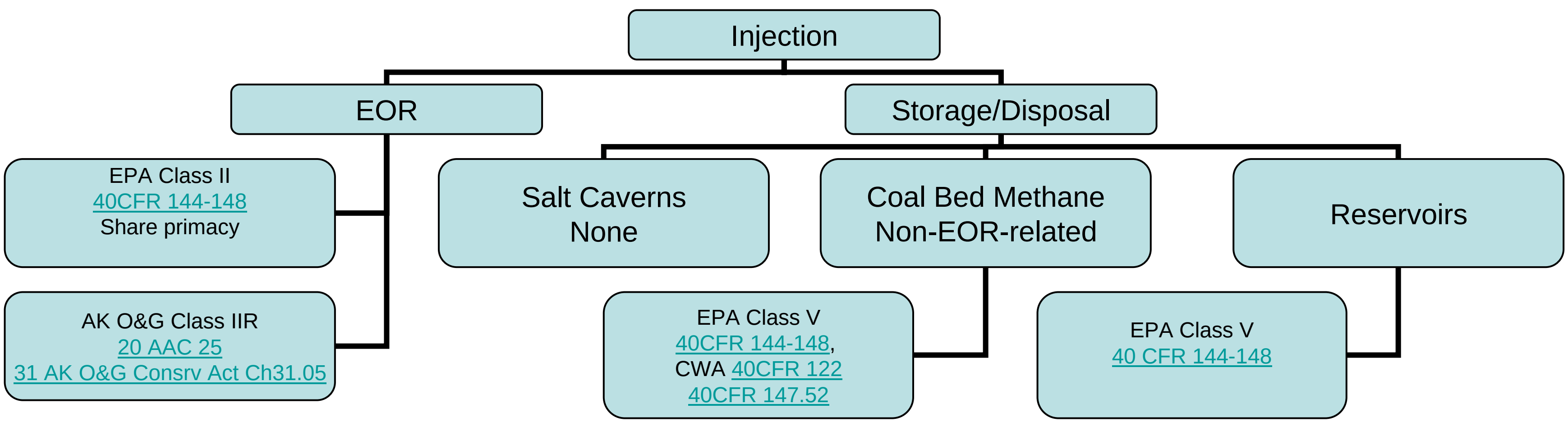
	Rangelands (million acres)	Suitable Rangelands (million acres)	Total t C after 40 yrs (million metric tons)
California	59.3	23.1 (39%)	1030
Oregon	26.9	19.1 (71%)	403
Washington	11.9	9.1 (77%)	335

Tons C per Hectare after 40 years

- 0 (or non-candidate)
- < 25
- 26 - 50
- 51 - 75
- 76 - 100
- 101 - 125
- 126 - 150
- 151 - 175
- 176 - 200
- > 201

Current Regulatory Framework Has Been Reviewed

- Regulatory framework varies from state to state
- Comparative assessment of regulations for enhanced oil recovery, natural gas storage, and underground waste injection
- Comparative assessment of regulations covering land use changes required for forest sequestration



Alaska storage regulations

Public Awareness Increased Through Outreach

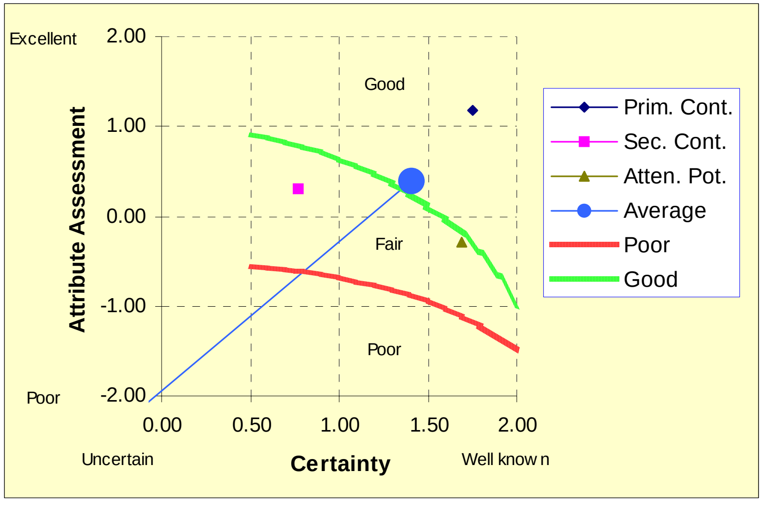
- Website
- News media interactions
- Meetings with state and local leaders
  - Ventura County
  - Portland forum
  - Lakeview, Oregon
  - Redding, California
- Norwegian CO_2 Study Tour
- Input to WGA CDEAC Clean Coal Task Force
- Input to CA Integrated Energy Policy Report

OREGON SOLUTIONS

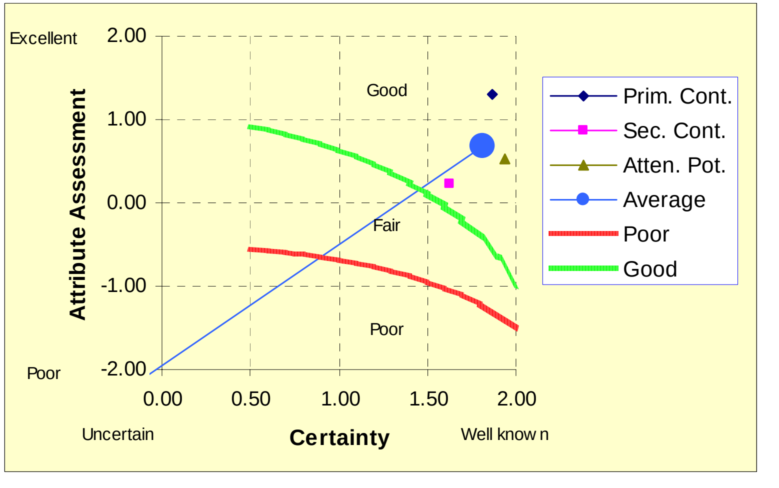
Tool Developed for Selecting Geologic Storage Sites

- Spreadsheet model for ranking/screening of sites, focused on assuring containment
- Three main controlling characteristics:
  - Primary containment potential
  - Secondary containment potential
  - Attenuation potential
- User can:
  - Evaluate and score various attributes
  - Specify the importance of various attributes through weighting factors
  - Specify uncertainty inherent at sites

Ventura Oil Field

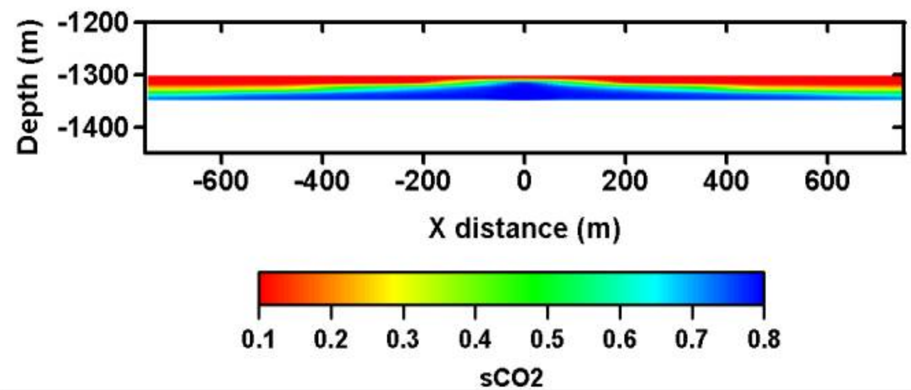


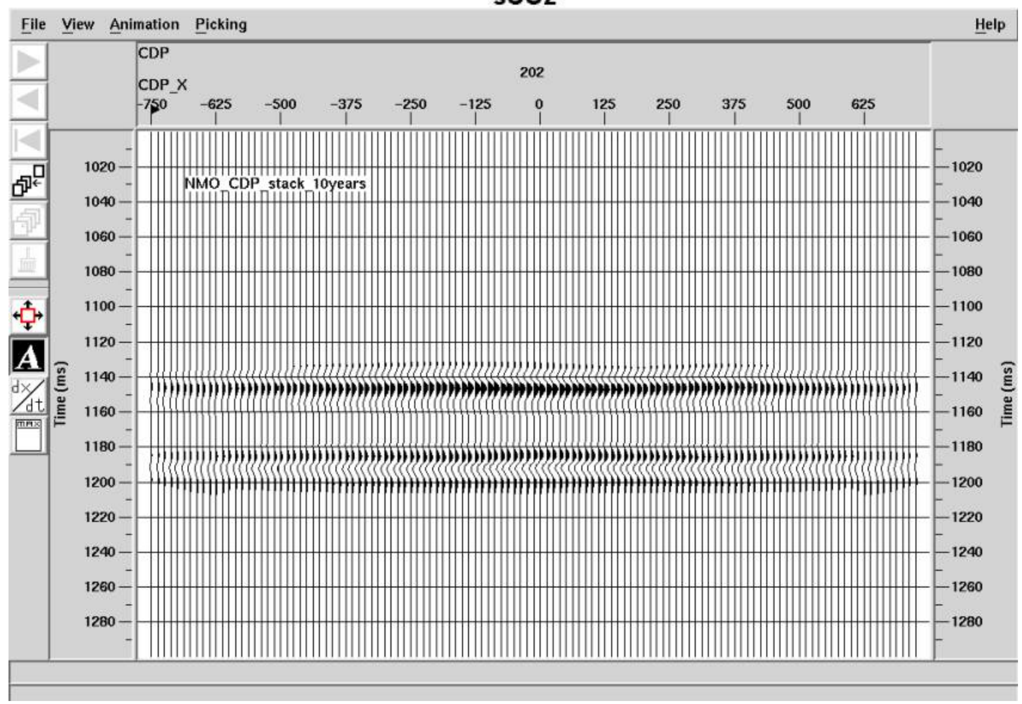
Rio Vista Gas Field



Development of Monitoring Protocols

- Assess applicable monitoring methods at sites of potential interest
  - Schrader Bluff
  - Rio Vista
- Work with partners to assemble data
- Use modeling to assess methods





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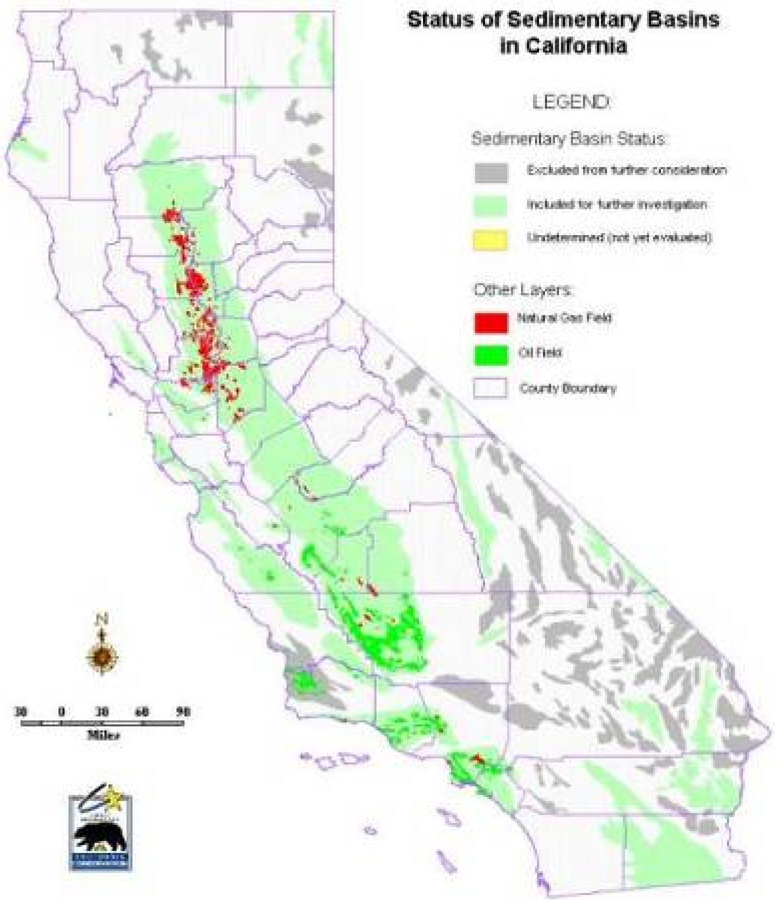
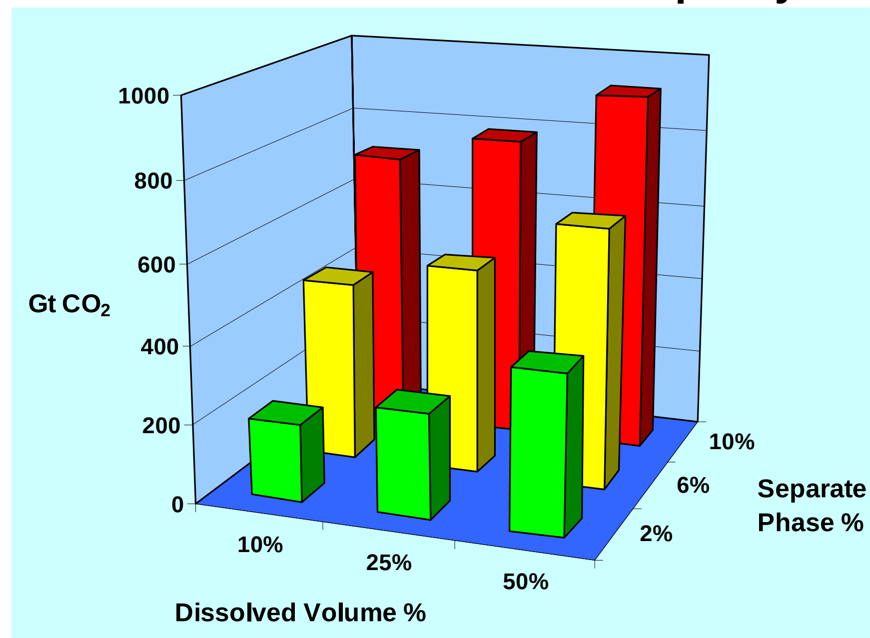
- **Geologic characterization studies**
- Defining best geologic options
- Terrestrial baselines and opportunities

California Sedimentary Basins Are Prime West Coast Sequestration Targets

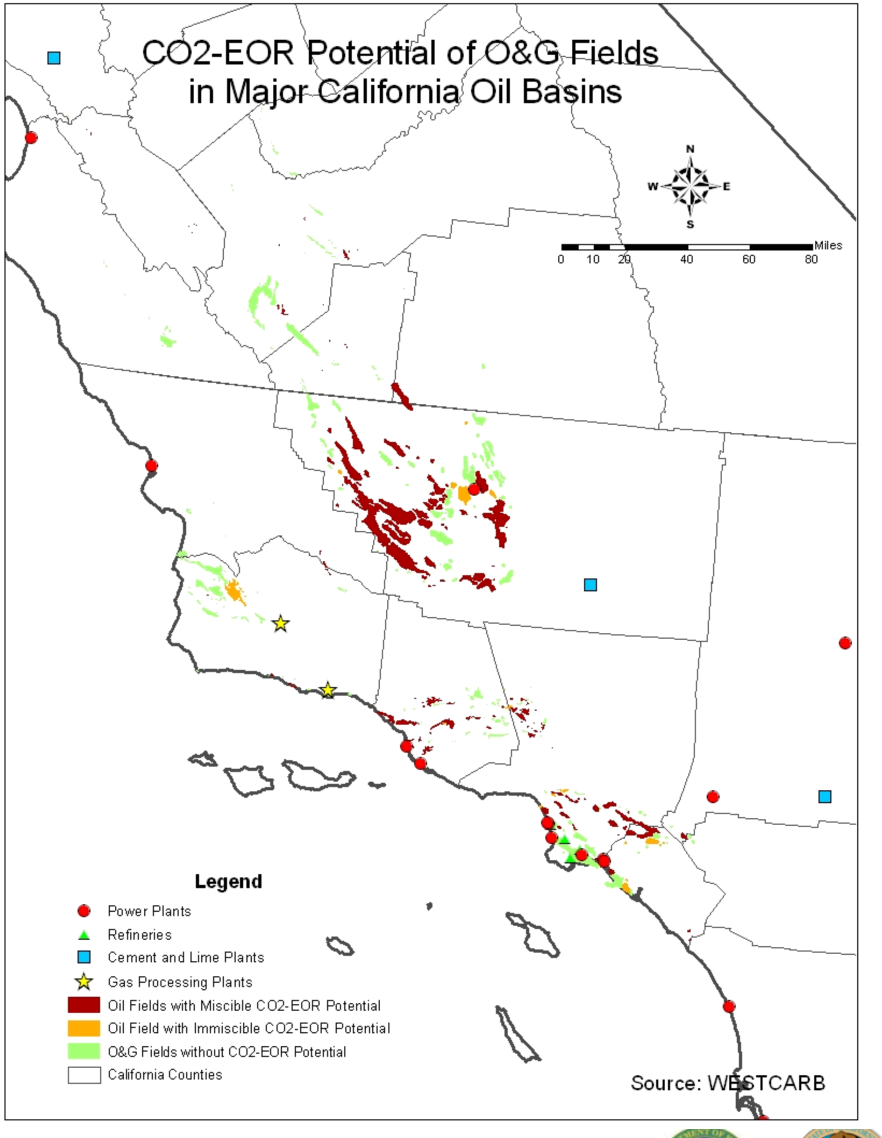


Saline Formation Total Capacity

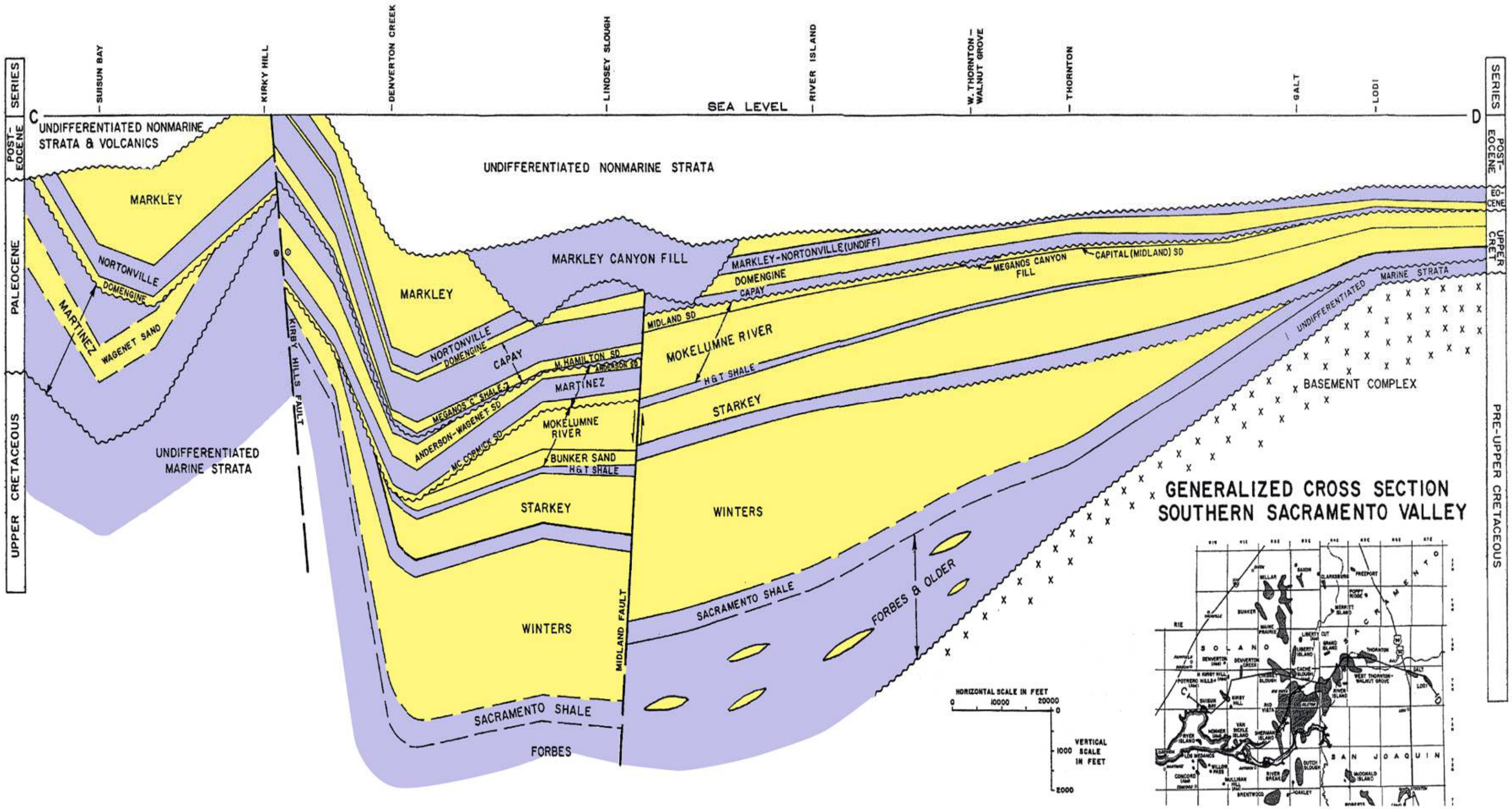


Opportunities for EOR and EGR Have Been Identified

- 121 fields met depth and miscible EOR criteria
  - 3.4 Gt CO_2 storage capacity (preliminary estimate using production as a basis)
  - Other studies suggest 5.4 billion barrels oil technically recoverable
- 128 gas fields met depth criteria
  - 1.8 Gt CO_2 storage capacity (preliminary estimate)

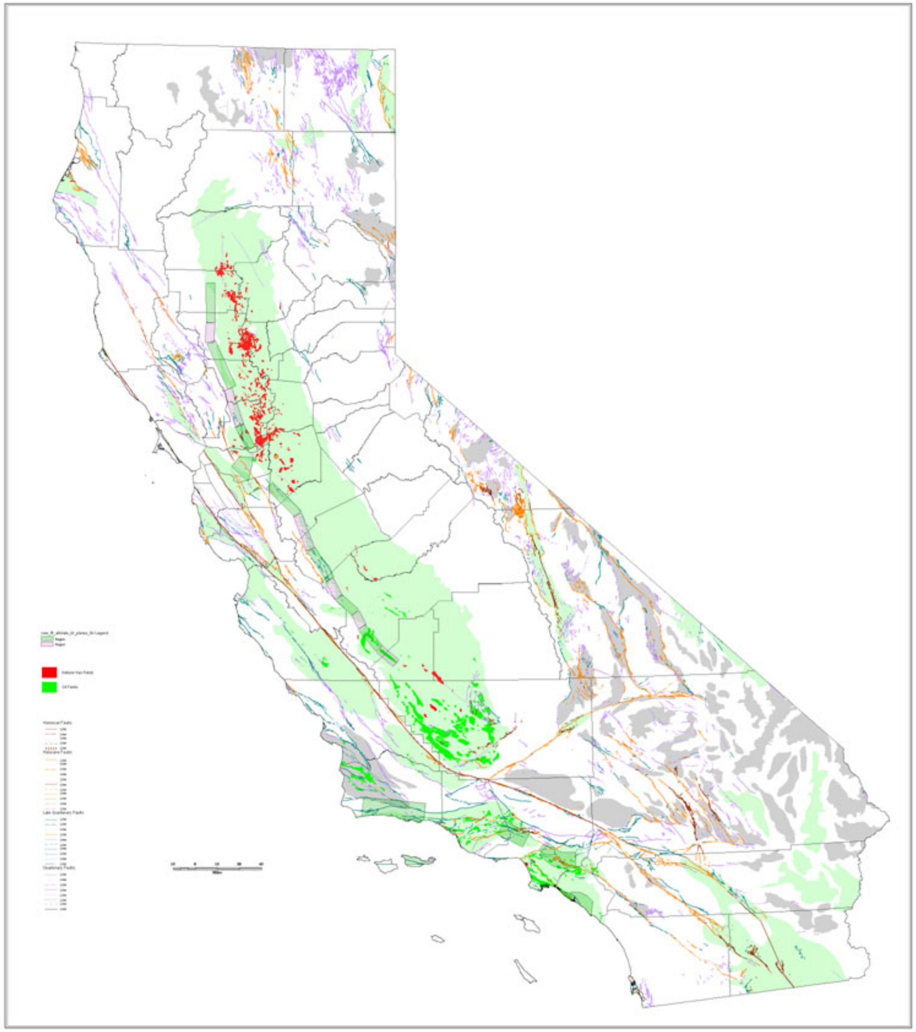


Generalized Cross-Section of Southern Sacramento Basin



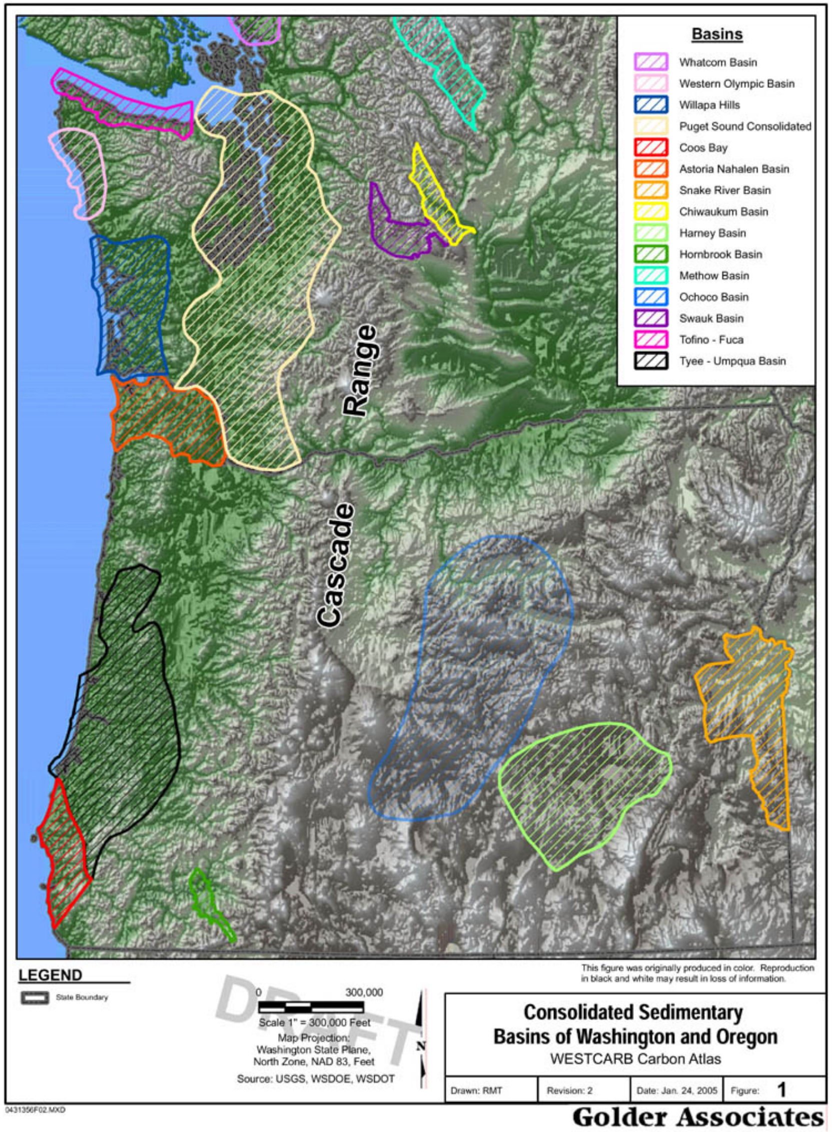
Low Occurrence of Quarternary Faulting in Many Basins

- Hydrocarbons have remained trapped in faulted basins
- In Central Valley, faulting is absent except at southern end; deep thrust faulting along western margin



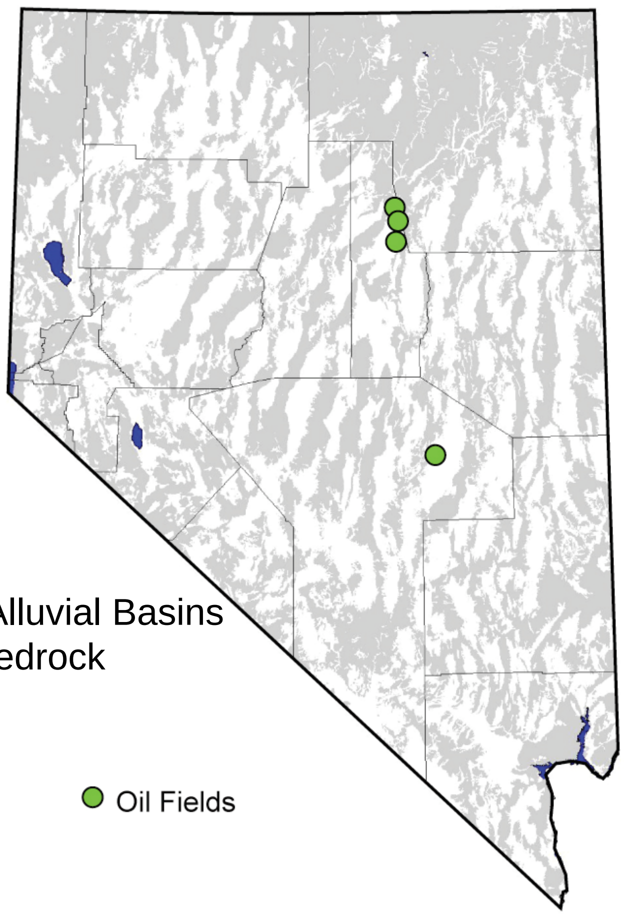
Consolidated Sedimentary Basins in Oregon and Washington

- Puget Trough and Whatcom basins are important targets
  - Sediment depths from 10,000 ft to 20,000 ft
  - Gas, coal present
  - Good porosity and permeability
- In OR, Western Tertiary Basins cover 20,000 sq miles with sediments up to 20,000 ft thick
- Basalts in eastern WA and OR underlain by sediments



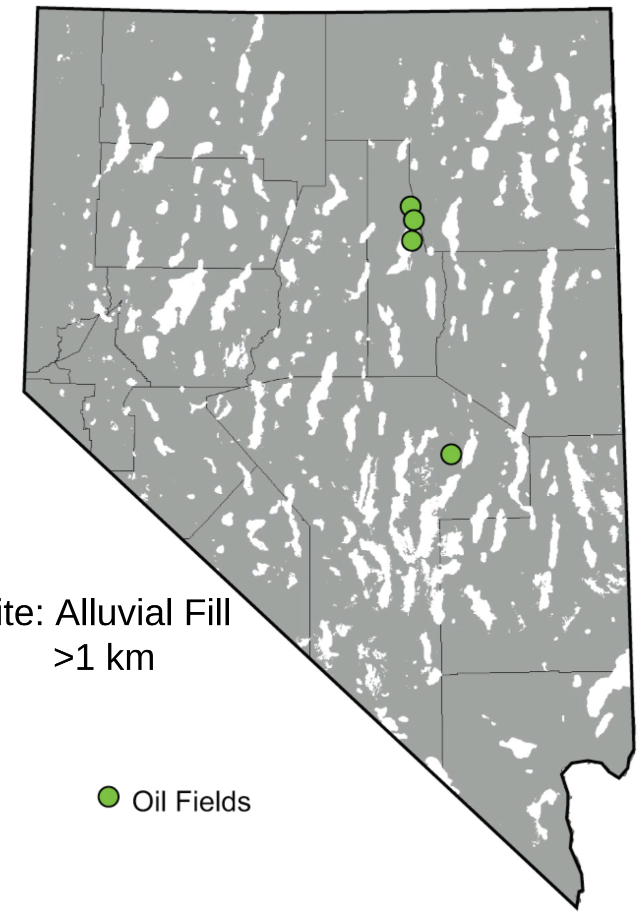
Alluvial Deposits in Basin and Range Offer Suitable Depth

Alluvial Deposits - White: Older Rock Units - Gray
R. Hess



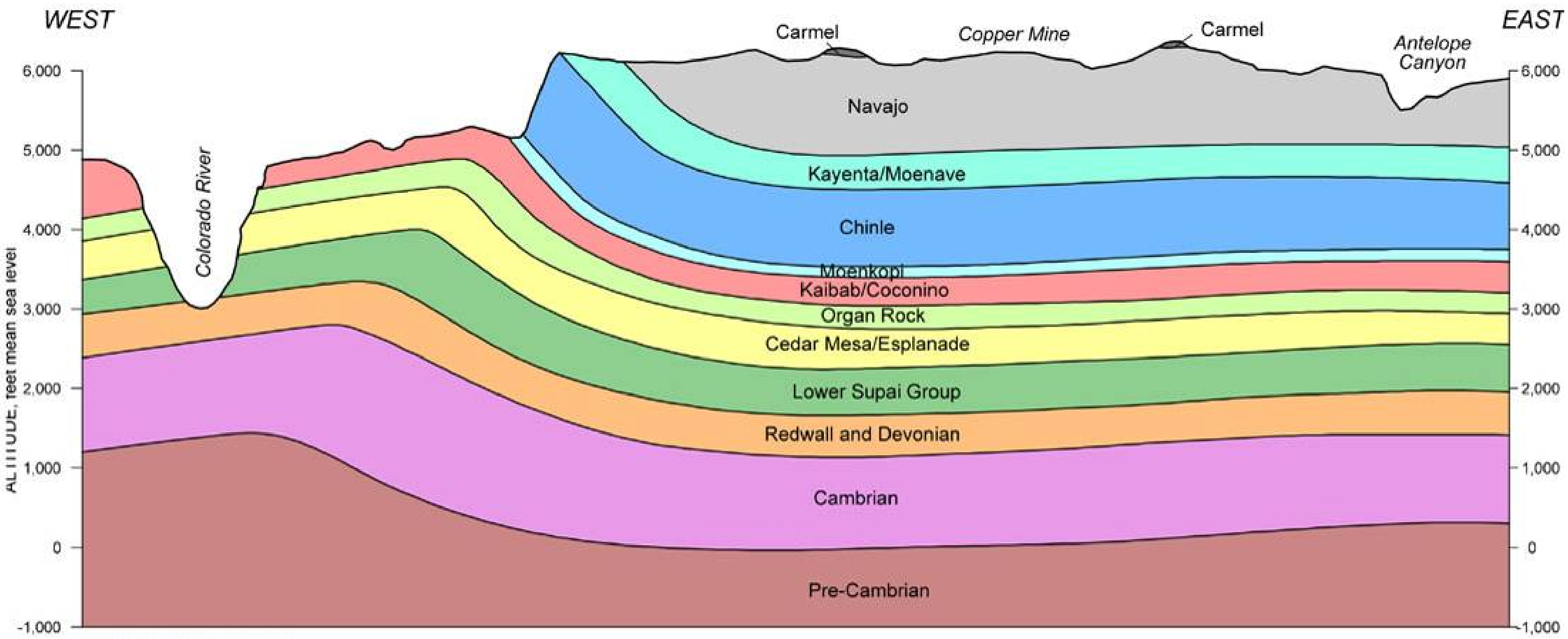
White: Alluvial Basins
Grey: Bedrock

Greater than 1k valley fill - white
R. Hess

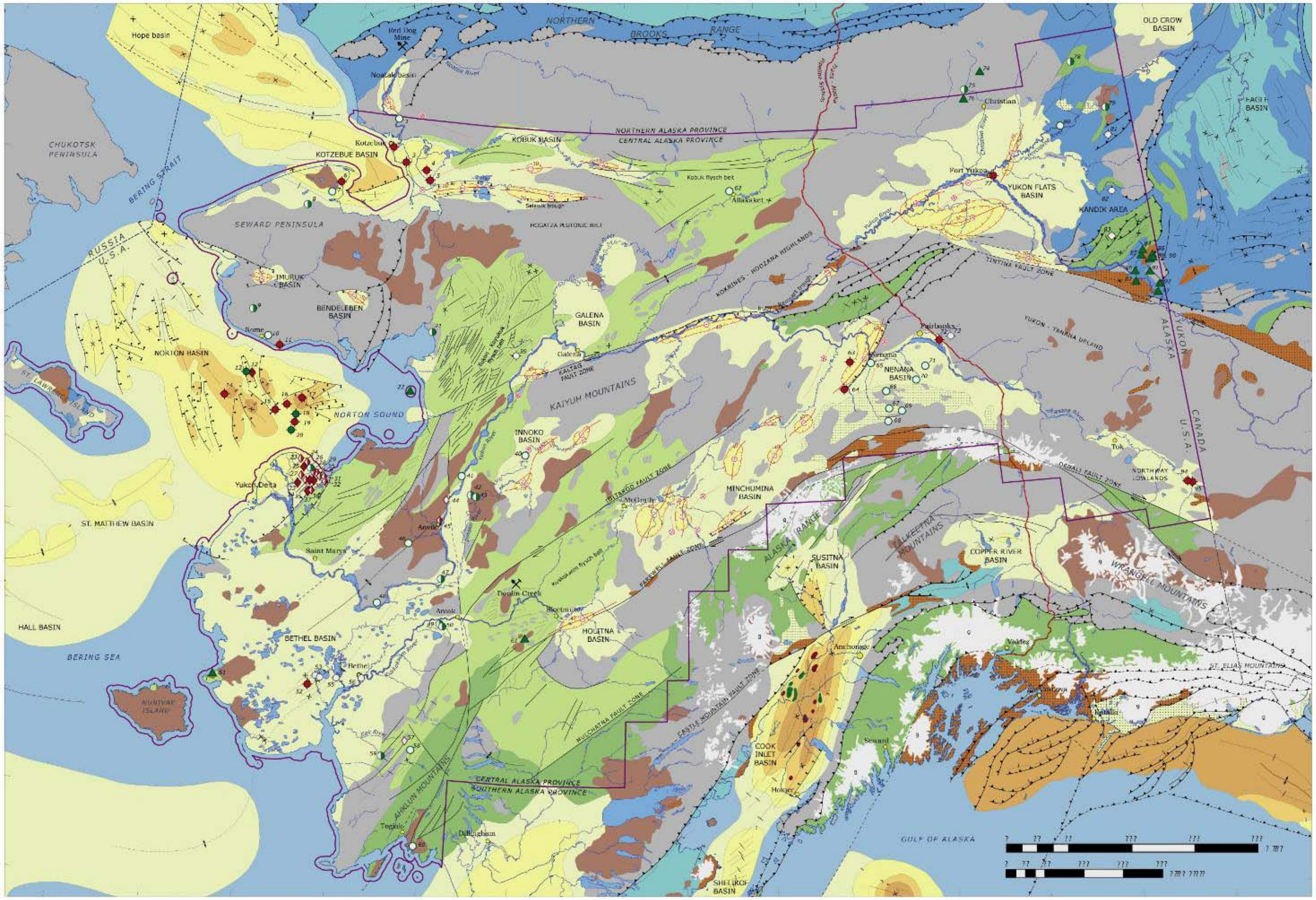


White: Alluvial Fill
>1 km

Colorado Plateau Is a Major Arizona Sink



At Least Six Alaskan Basins Contain Sediments >1 km Thick



A. Sedimentary basins and selected geologic features of regional importance.

Outline

- Phase I overview
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- **Defining the best geologic options**
- Terrestrial baselines and opportunities

Defining the Best Geologic Options

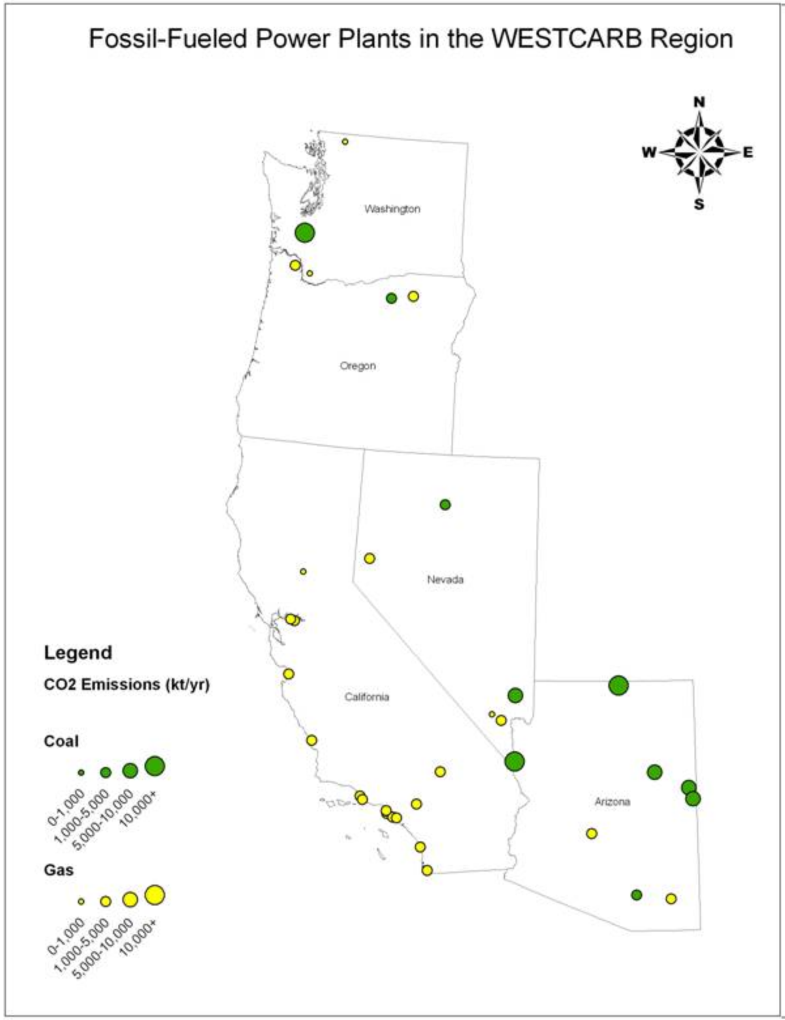
- CO_2 Source Analysis
- CO_2 Storage Capacity Estimation
- Transportation Cost Estimation
- Source-Sink Matching

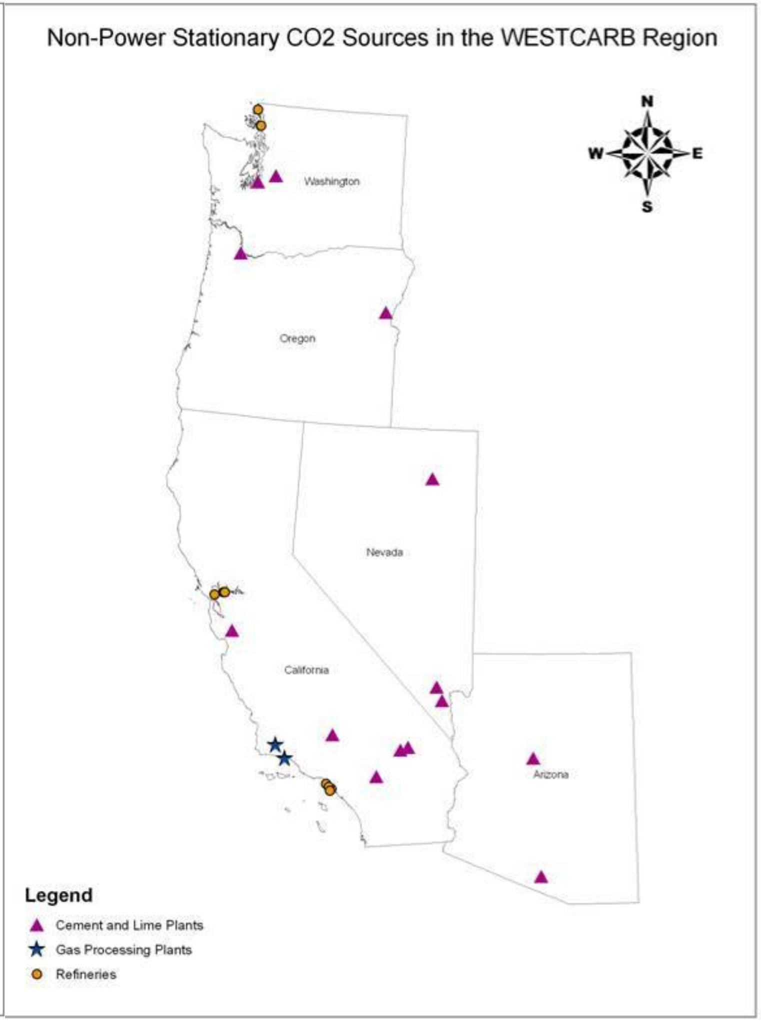
CO_2 Sources

State	Power Facilities		Refineries		Cement Lime		Gas Processing	
	Facilities #	CO2 Emissions (kt/yr)	Facilities #	CO2 Emissions (kt/yr)	Facilities #	CO2 Emissions (kt/yr)	Facilities #	CO2 Emissions (kt/yr)
AK	6	2,289	3	2,642	0	0	3	0
AZ	9	48,070	0	0	2	1,424	0	0
CA	18	25,070	7	11,312	6	6,016	2	0
NV	5	21,960	0	0	3	0	0	0
OR	4	7,992	0	0	2	597	0	0
WA	3	12,059	3	4,046	3	774	0	0
Total	45	117,439	13	18,000	16	8,811	5	0

- Mainly power generation sources
- No data for gas processing

CO_2 Sources (cont'd)

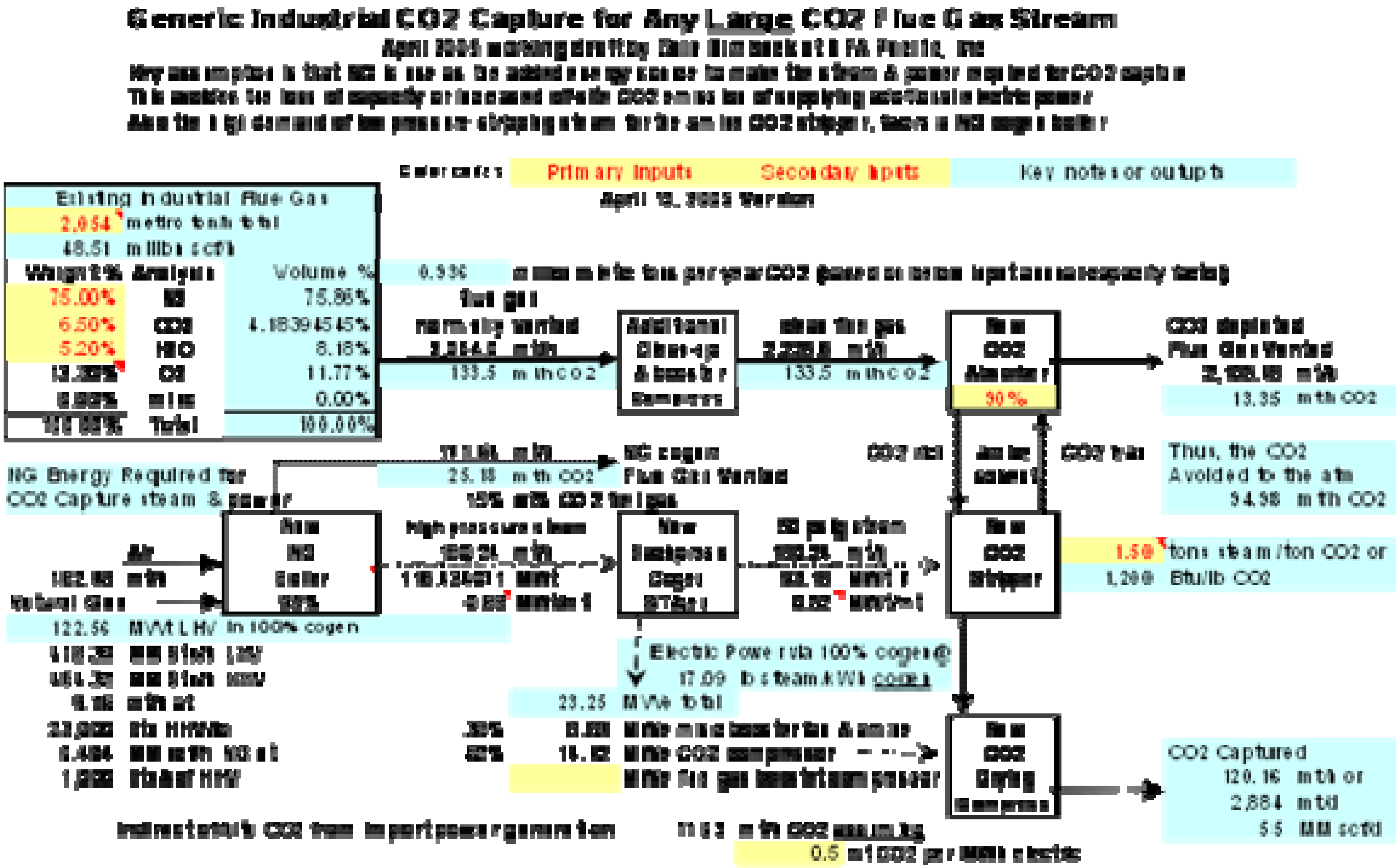




CO_2 Capture Cost Estimation

- Methodology
  - "Generic CO_2 Capture Retrofit" spreadsheet prepared by SFA Pacific, Inc.
    - Flue gas flow rate (in metric tonnes per hour)
    - Flue gas composition (volume share or weight share of CO_2 in flue gas)
    - Annual load factor
- Assumption
  - Power plants, once installed with capture facility, will operate at 80% of their designed capacities

CO_2 Capture Cost Estimation (cont'd)



Note: Values shown are hypothetical

CO_2 Capture Cost Estimation (cont'd)

Capital Costs		Unit cost at [illegible]		[illegible] factors	Actual unit cost at		millions of $ [illegible]	Notes
		60	[illegible]		120	mt/h CO2	[illegible] dollars	
NG boiler	$	15	[illegible]	75%	$13	lb/hr steam	[illegible]	
[illegible] ST gen	$	500	[illegible]	75%	$420	/kWe	[illegible]	
Additional cleanup	$	-	[illegible]	75%	$0	m t/h flue ga	-	[illegible] SO2, NOx cleanup
[illegible]	$	800	[illegible]	75%	$672	/kWe	-	needed in many cases
CO2 absorber	$	25,000	[illegible]	75%	$21,015	m t/h flue ga	[illegible]	
CO2 Stripper	$	200,000	[illegible]	75%	$168,124	m t/h CO2	[illegible]	
CO2 Compressor	$	1,000	[illegible]	75%	$841	/kW	12.1	
					Total process units		[illegible]	
General Facilities			20%	of process units			[illegible]	[illegible] typical
Eng. Permitting & Startup			10%	of process units			[illegible]	10-[illegible] typical
Contingencies			10%	of process units			[illegible]	10-[illegible] typical
Working Capital, Land & Misc.			5%	of process units			[illegible]	5-[illegible] typical
					U.S. Gulf Coast Capital Costs		[illegible]	
Site specific factor		110%	of US Gulf Coast		Total Capital Costs		149.7	CA costs are likely higher than Gulf Coast

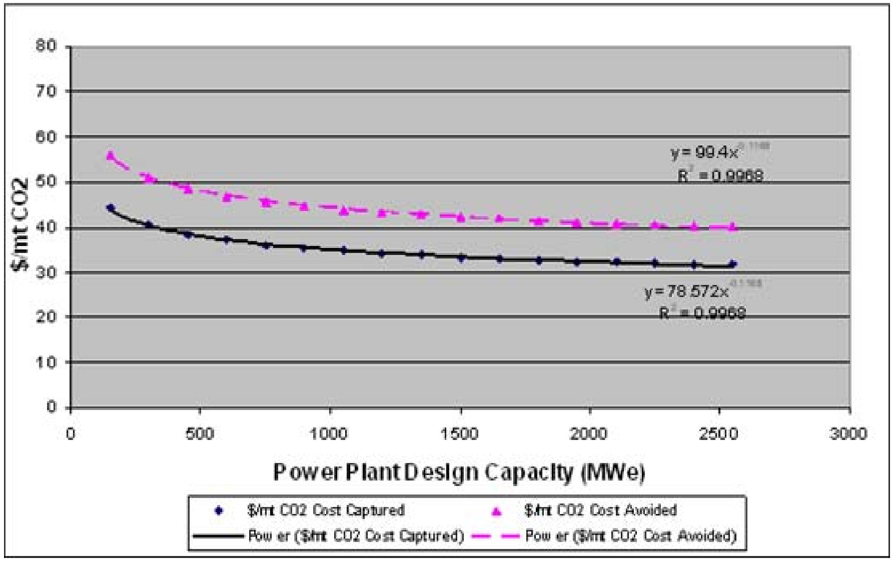
CO2 Costs					[illegible] of CO2	$/mt CO2 Cost		Notes
		80%	ann load factor	[illegible]	Capture	Capture	Avoided	high ann load is critical to cost
Variable Non-fuel O&M		1.0%	[illegible]	1.5	[illegible]	1.78	2.25	0.5-1.5% typical
Natural Gas	$	5.00	[illegible]	[illegible]	[illegible]	[illegible]	24.44	[illegible] industrial rate
Carbon Tax	$	10.00	[illegible]	[illegible]	[illegible]	[illegible]	0.38	[illegible]
Total Variable Operating Cost				[illegible]	[illegible]	[illegible]	27.08	
Fixed Operating Cost		5.0%	[illegible]	[illegible]	[illegible]	[illegible]	11.25	[illegible] typical for refining
Capital Charges		15%	[illegible]	[illegible]	[illegible]	[illegible]	33.74	[illegible]
			Total CO2 Costs	[illegible]	[illegible]	[illegible]	72.07	including return on investment

Note that the difference between capture and avoided CO2 costs is due to the energy required for CO2 capture steam & power

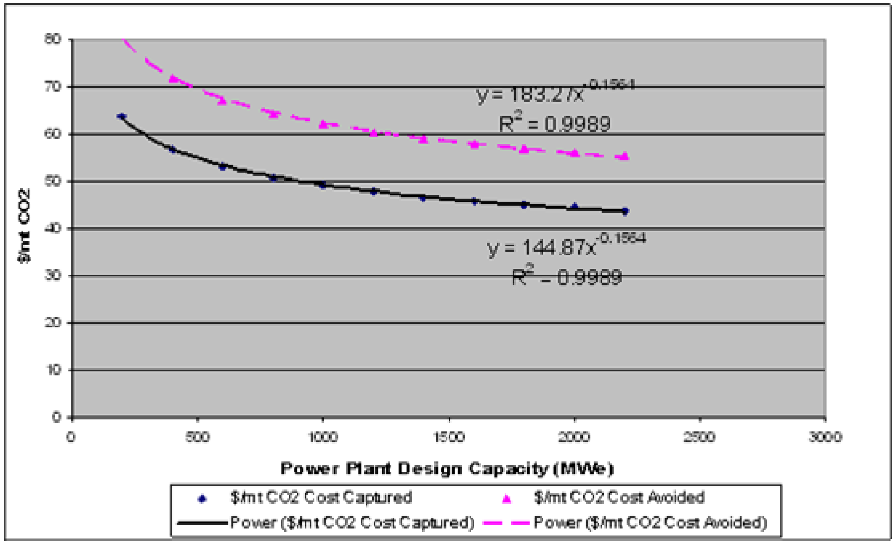
Note: Values shown are hypothetical

CO_2 Capture Cost Estimation (cont'd)

Coal



Natural Gas

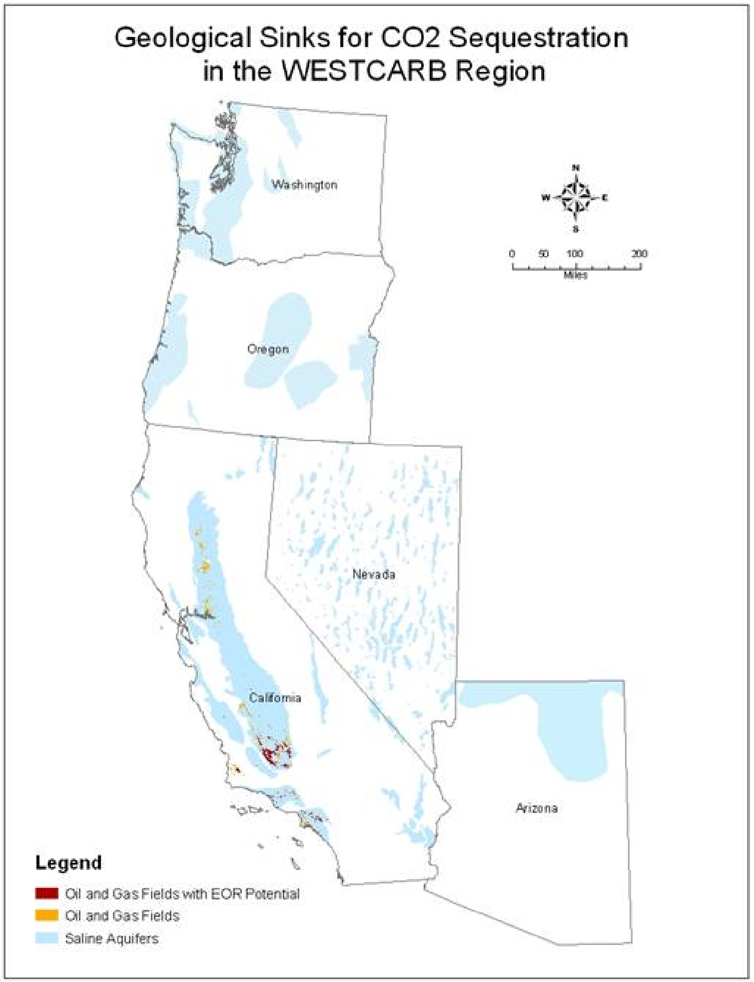


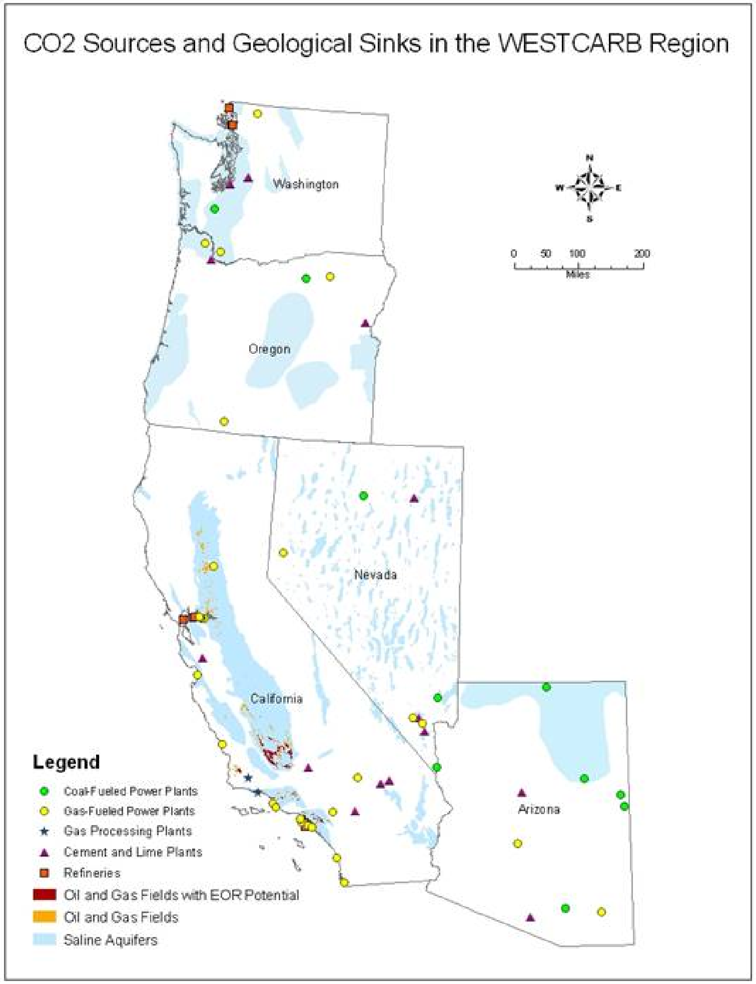
- Nat Gas @ $5/MBtu
- No Carbon Tax

CO_2 Storage Capacity Estimation

- Oil & Gas
- Saline Reservoirs

Geological Sinks





Storage Capacity

- For any hydrocarbon field, the CO_2 storage capacity is the underground volume of oil and gas that have been produced
  - Conservative but consistent method
- The storage capacity of saline reservoirs depends on the available pore volume and the CO_2 storage efficiency in fully water-saturated reservoirs

Transportation Cost Estimation

- Pipeline Design Capacity
- Pipeline Diameter
- Obstacle Layers for CO_2 Transportation
- Pipeline Cost

Pipeline Design Capacity

- For refineries and cement and lime plants, pipeline design capacity equals the 2002 CO_2 emission multiplied by a default capture efficiency (90%)
- For power plants, the designed pipeline capacity is calculated as following:

$$VC_{CO2} = \frac{VE_{CO2}^{2002}}{OE^{2002}} * CE_0$$

where

VC_{CO2} = Annual captured CO_2 flow (ton)

VE_{CO2}^{2002} = 2002 annual CO_2 emission (ton)

OE^{2002} = 2002 plant operating factor

CE_0 = Default CO_2 capture efficiency (90%)

Pipeline Diameter Calculation

- Assumes that standard pipelines in the gas industry will be used in CO_2 transportation. The pipeline diameter increases in 4 inch increments (after 4, 6, and 8 inches).

Pipeline Diameter (inch)	CO_2 Flow Rate (Mt/yr)	
	lower bound	upper bound
4		0.19
6	0.19	0.54
8	0.54	1.13
12	1.13	3.25
16	3.25	6.86
20	6.86	12.26
24	12.26	19.69
30	19.69	35.16
36	35.16	56.46

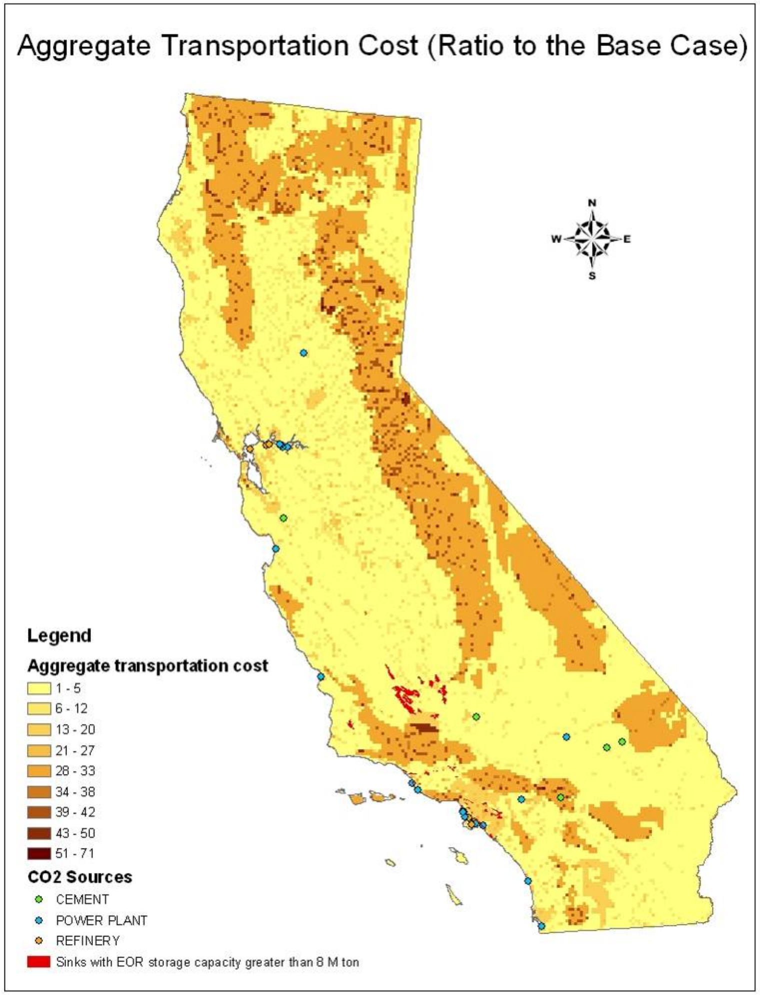
Crossing Cost Factor

Estimated Relative Crossing Cost Factor

Construction Condition	Cost Factor
Base Case	1
Slope	
10-20%	0.1
20-30%	0.4
>30%	0.8
Protected Area	
Populated Place	15
Wetland	15
National Park	30
State Park	15
Crossing	
Waterway Crossing	10
Railroad Crossing	3
Highway Crossing	3

Aggregate Crossing Cost Factor Calculation Example

- Aggregate Crossing Cost factor =
  1 (base case)
  +slope factor
  +Populated area*15
  +Wetland*15
  +National Park*30
  +State Park*15
  +Waterway*10
  +Railroad*3
  +Highway*3



Transportation Cost Calculation

- Base Case Construction Cost
  - The base case pipeline construction cost is estimated to be $12,000/in/km
- Crossing Cost
  - The obstacle crossing cost is calculated as the product of the relative weight and the base case construction cost for an 8 inch pipeline, but is assumed to be the same for pipelines of any diameter
- Operation and Management Cost
  - The O&M cost is estimated to be $3,100/km per year, independent of pipeline diameter

Source-Sink Matching

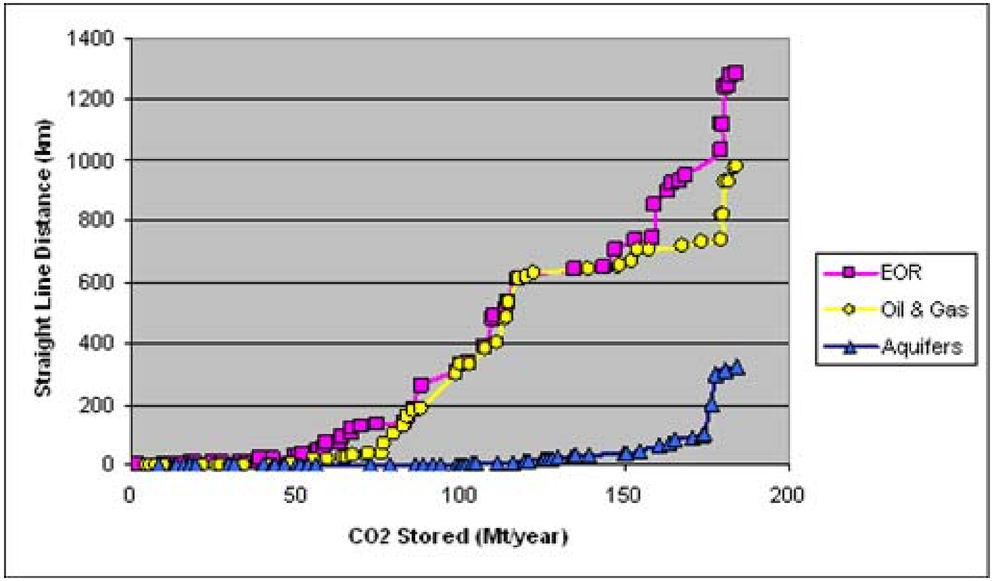
- Distance-Based Source-Sink Matching
- California Study
  - Full-Cost
  - Optimized Transportation
  - Storage Cost
    - For EOR Uses, EOR Credit
    - For Saline Reservoir Uses, Costs Developed by DOE/EPRI/TVA

Distance Based Source-Sink Matching

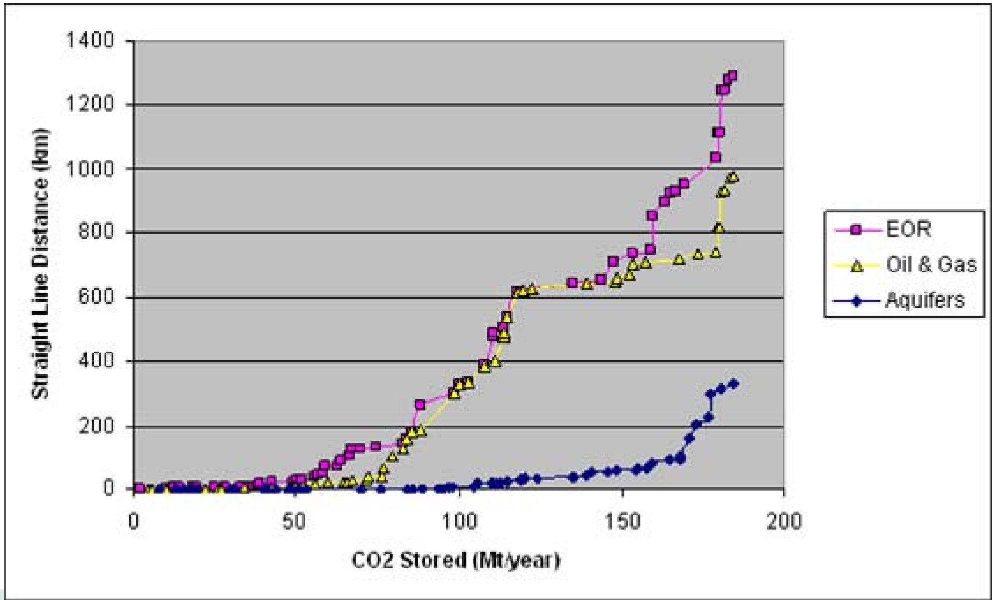
- For all sinks and sources in region
- Straight line matching
- Sink capacity constraint is not considered
- Gives a sense of minimum transport costs where the geological information is not sufficient to do a full cost evaluation

Distance Based Source-Sink Matching (cont'd)

With Nevada reservoirs



Without Nevada reservoirs



California Study

- For sinks and sources in California only
- Least-cost path matching
- Sink capacity constraint is considered
- Transportation obstacle layers are applied
- A cost allocation iteration is used for source-sink matching

Fields Classification

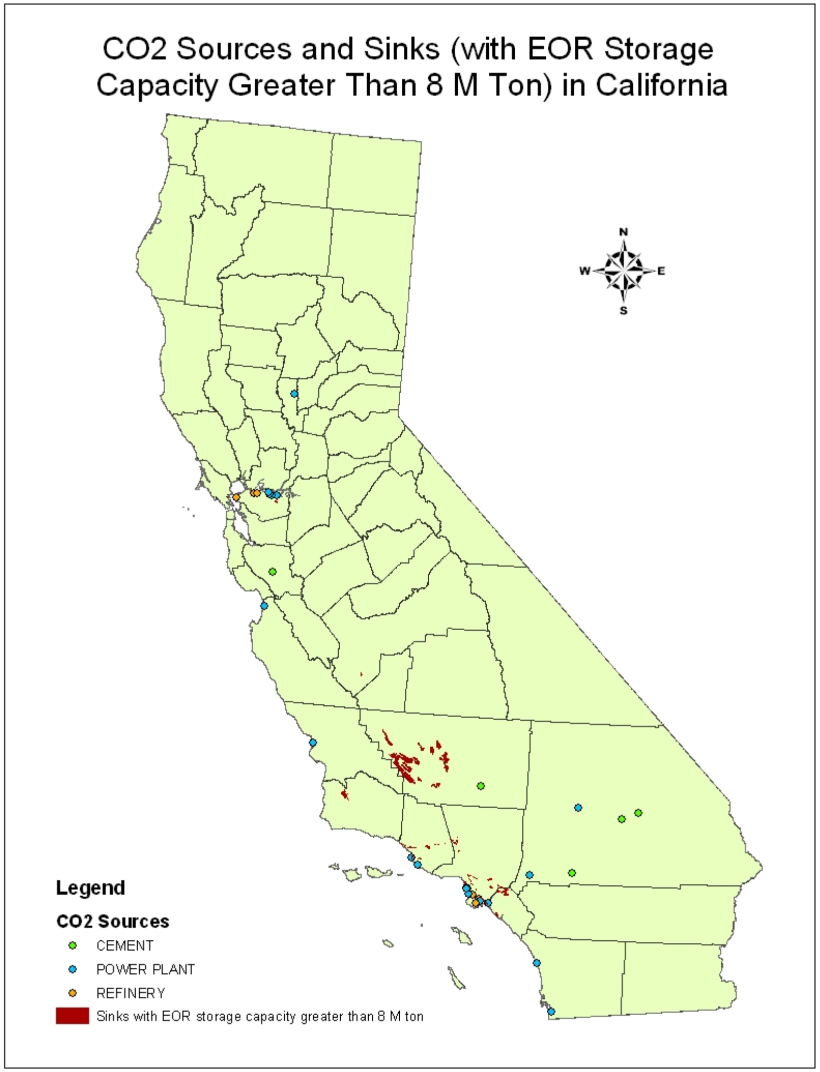
- Oil fields are classified into five categories
  - **Fields with miscible CO_2-EOR potential (depth >3000 feet, API>25)**
  - **Fields with immiscible CO_2-EOR potential (depth >3000 feet, 17.5<API<25)**
  - **Fields with CO_2 storage potential but no EOR potential (depth >3000 feet, API<17.5)**
  - Fields without CO_2 storage (depth <3000 feet)
  - Fields undetermined (depth or API missing)
- Gas fields are classified into three categories
  - **Fields with CO_2 storage potential (depth >3000 feet)**
  - Fields without CO_2 storage potential (depth <3000 feet)
  - Fields undetermined (depth missing)

CO_2 Sinks with EOR Potential

- Miscible Application of CO_2-EOR
  - Number of Fields: 124
  - Total Storage Capacity: 3284 Mtons (preliminary estimate)
- Immiscible Application of CO_2-EOR
  - Number of Fields: 20
  - Total Storage Capacity: 176 Mtons (preliminary estimate)

Sources and Sinks in Matching

- 32 Sources
- 55 Sinks with EOR storage capacity greater than 8 million tons



Work Flow

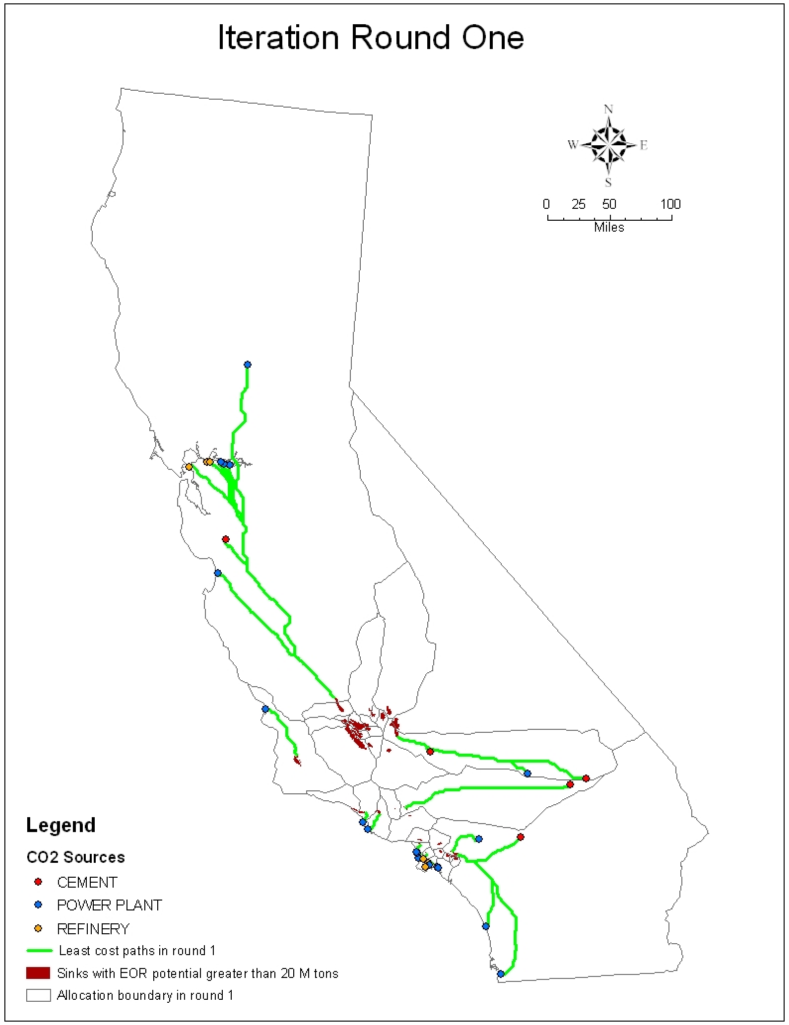
- Standard Iteration
  - Doing cost allocation with the sink layer
  - Get the least cost paths for each source to the corresponding sink
  - Calculate the aggregate in-flow CO_2 for each sink, comparing with its storage capacity
  - If none of the sinks is overflowed – DONE! Exit the iteration.

Work Flow (cont′d)

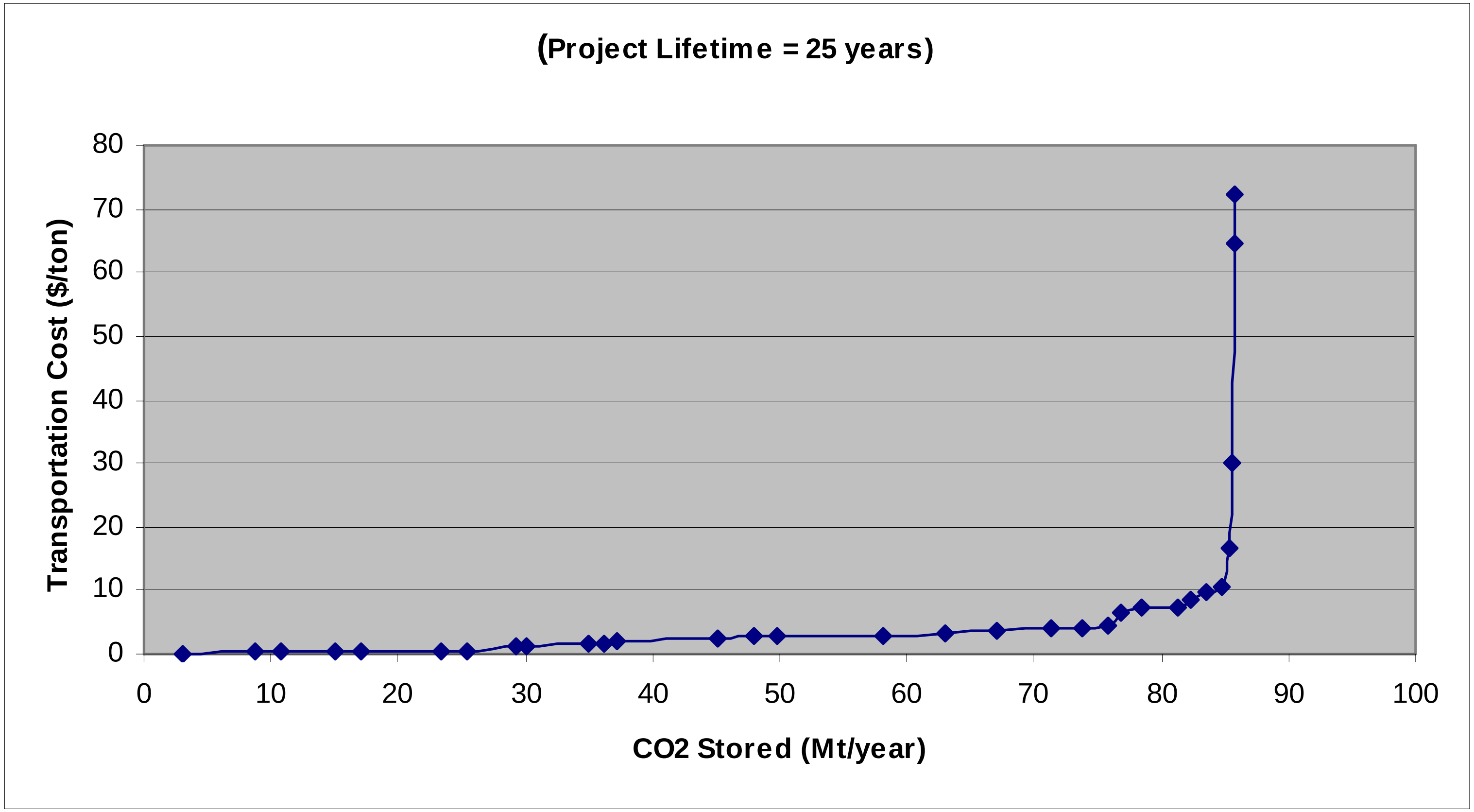
- If a sink is overflowed, exclude sources based on their distances to the sink, until remaining CO_2 in-flow is less than the storage capacity. Further sources will be excluded earlier.
- Set the new source layer as all excluded sources in the above step
- Set the new sink layer as all the sinks with remaining storage capacity
- Start next iteration with the new source layer and new sink layer

Application

- First of 8 Iterations

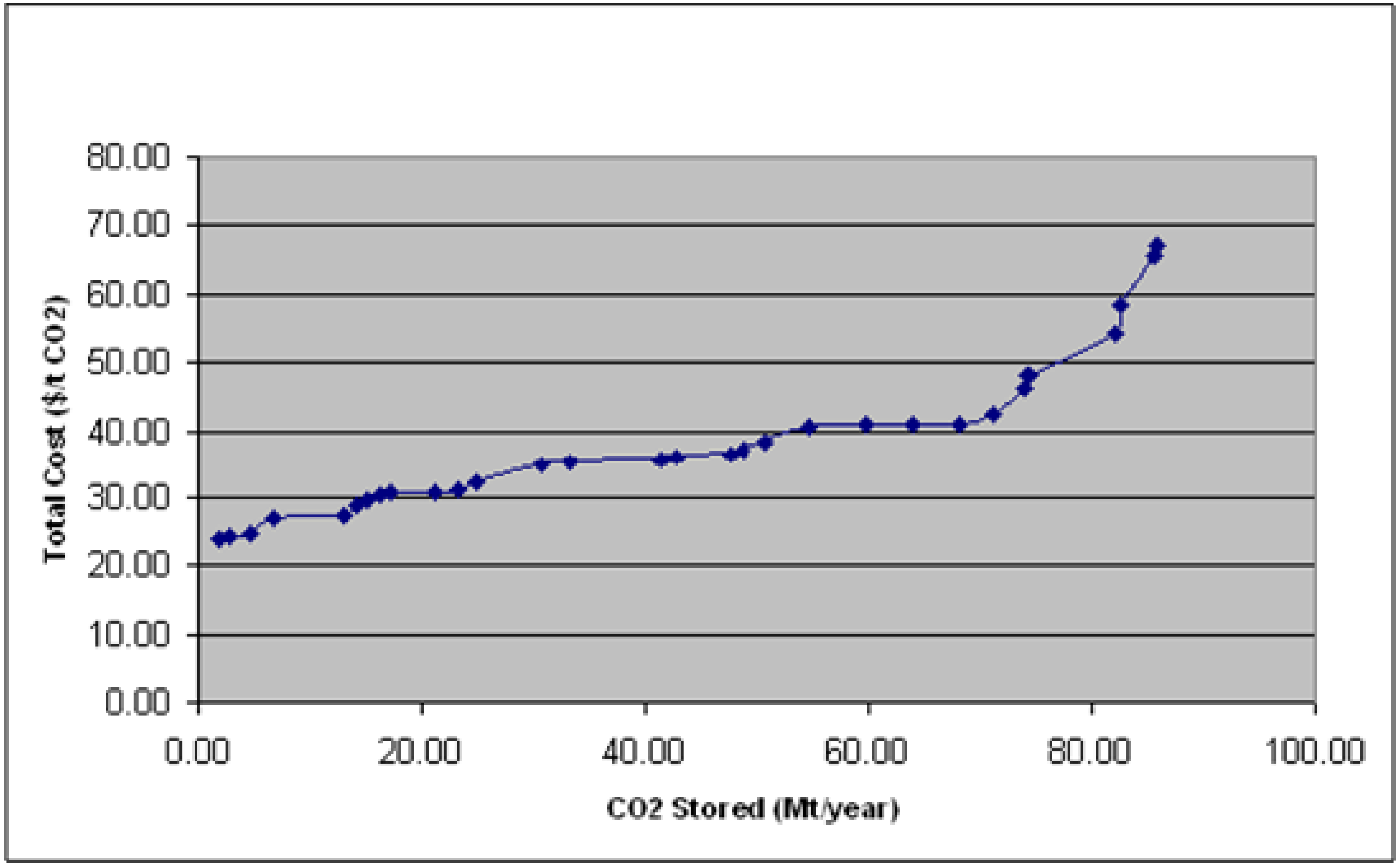


Marginal Transportation Cost by Annual CO_2 Storage Rate in California EOR Oil Fields



Supply Curves for Capture and Geologic Storage Assume Present-Day Conditions

California Marginal Cost by CO_2 Storage Rate



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Phase I Findings: Terrestrial Sequestration

- Baselines prepared for Arizona, California, Oregon, and Washington
- Terrestrial sequestration opportunities quantified for California, Oregon, and Washington
  - Area, tons, cost
  - Largest terrestrial sequestration opportunity in each state is afforestation
- Pilot projects identified for Lake County in Oregon and Shasta County in California

Baselines

- Forest area increasing in Oregon and Arizona and decreasing in Washington and California
- Carbon stocks increasing in all but Washington
- Emissions from conversion of land for development highest in Washington
- Significant emissions from fire in California and Oregon
- Emissions from ag lands are low and dominated by emissions of non-CO_2 gases

Forests

	California	Oregon	Washington	Arizona
Change in area - **acres/year**	- 83,500 ***- 0.21%/yr***	+ 94,700 ***+ 0.33%/yr***	- 62,800 ***- 0.28%/yr***	+ 54,200 ***+ 0.28%/yr***
Change in carbon stocks - **$MMTCO_2e$/yr**	+ 18.2	+ 23.0	- 12.6	+ 0.92

From USFS published data, forestland only. Change in carbon represents change in carbon stored in live trees.

Development *(forests only, rangelands excluded)*

Analyzed from National Resources Inventory (NRI) and Forest Inventory Analysis (FIA) datasets. Remote sensing analysis from ODF and LCMMP Program.

		California	Oregon	Washington	Arizona
NRI	Change in area - acres/year	- 16,760	- 6,890	- 24,570	- 350
	Change in carbon stocks - $MMTCO_2e/yr$	- 3.77	- 1.39	- 6.54	- 0.015
Remote Sensing	Change in area - acres/year	- 12,247* *just for Northern California*	- 5,500** *ODF / USFS*		
	Change in carbon stocks - $MMTCO_2e/yr$	- 0.80* *just for Northern California*			

*Analysis from LCMMP dataset in California, 3 regions represent 84% of total forests in State, 42% of rangelands

**Analysis from ‘Forests, Farms, and People,’ conducted by ODF, USFS

Fire *(includes both forests and rangelands)*

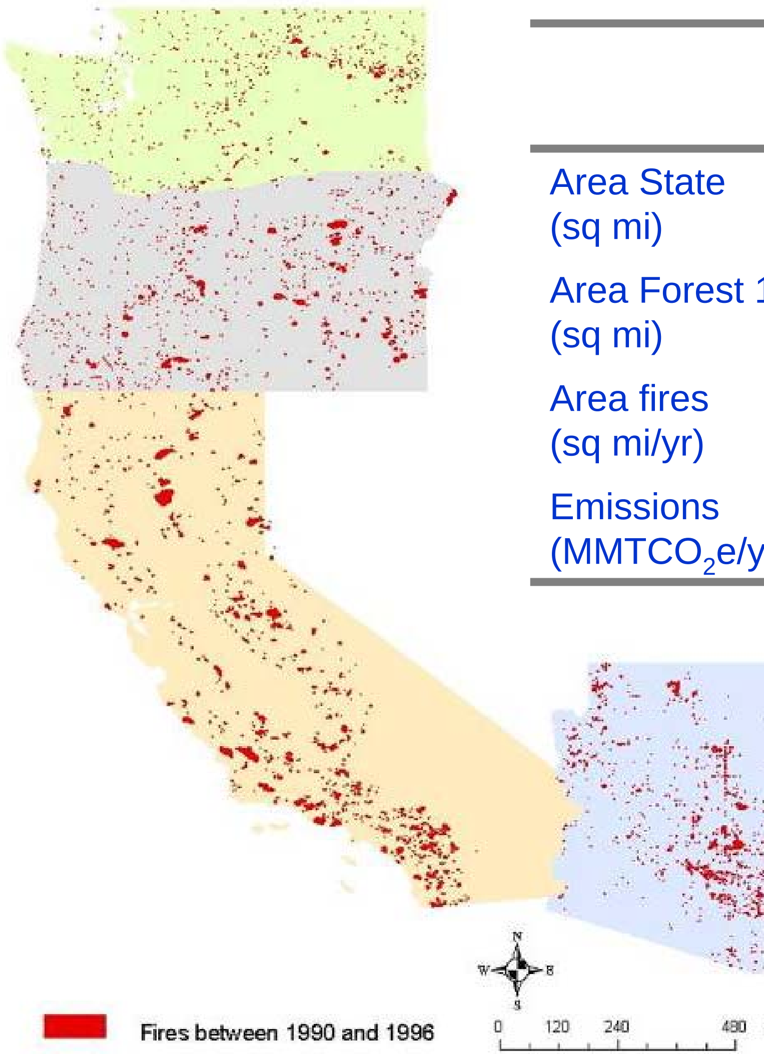
	California	Oregon	Washington	Arizona
Change in area **- acres/year**	**- 39,262*** *just for Northern California*	**- 13,510**	**- 2,920**	**- 15,400**
Change in carbon stocks **- MMTCO$_2$e/yr**	**- 1.46*** *just for Northern California*	**- 1.03**	**- 0.18**	**- 0.47**

**Analysis from LCMMP dataset in California, 3 regions represent 84% of total forests in State, 42% of rangelands*

Overall fire emissions are small compared with emissions from electricity generation or transportation or potential sequestration from afforestation, but reducing fire emissions by reducing hazardous fuels can have additional benefits:

- reduce cost of fire fighting
- reduce property damage
- reduce cost of insurance
- avoid fossil fuel emissions
- provide benefits to biodiversity and clean air

Fire (1990–1996)



	CA	OR	WA	AZ
Area State (sq mi)	163,707	98,386	71,303	114,006
Area Forest 1997 (sq mi)	60,228	46,438	34,208	31,134
Area fires (sq mi/yr)	484	21*	4.6*	24
Emissions ($MMTCO_2e/yr$)	1.46**	1.03	0.18	0.47

* Fire data are missing for 1994 in Oregon and Washington due to satellite failure

**Analysis from LCMMP dataset in California, 3 regions represent 84% of total forests in State, 42% of rangelands

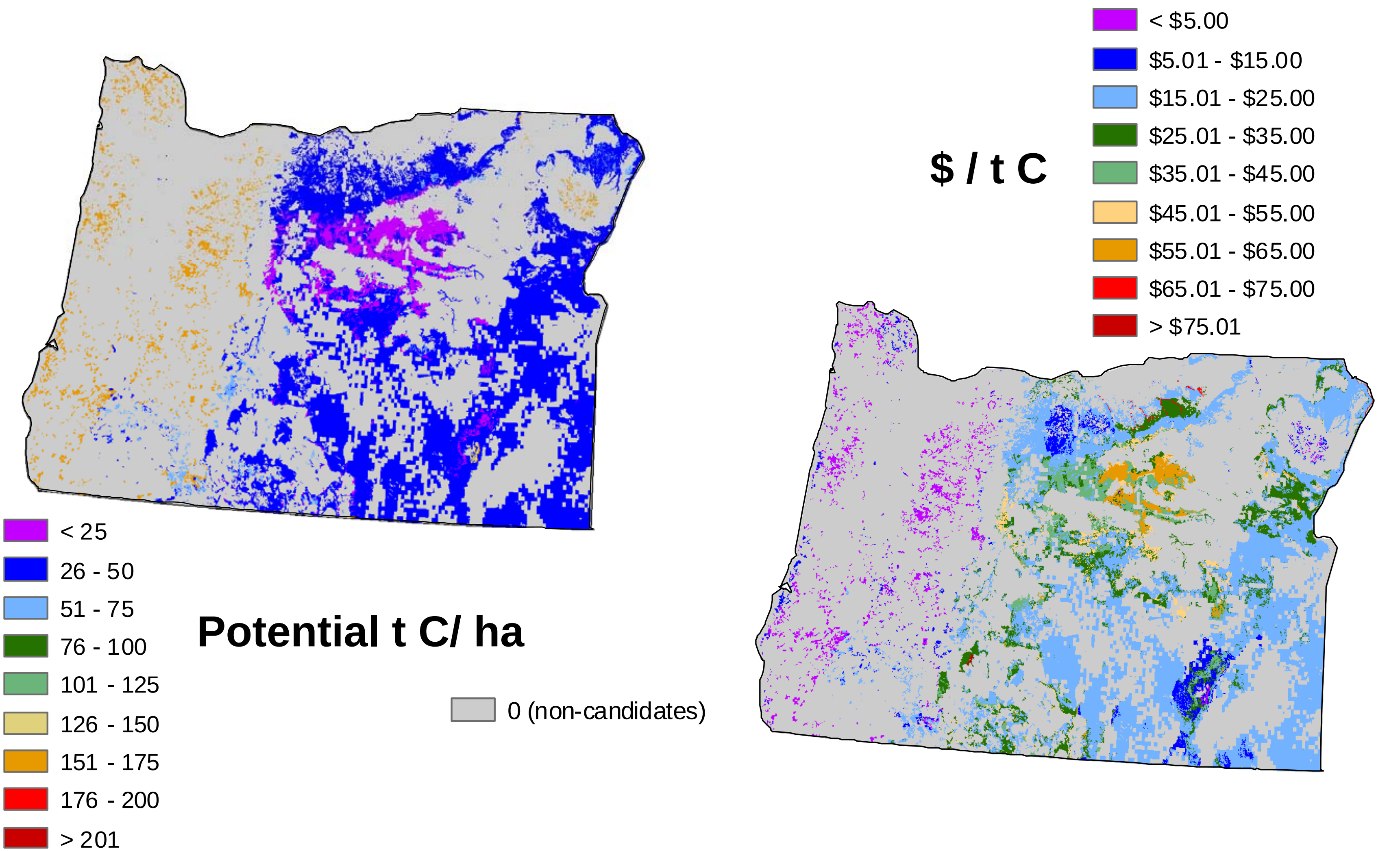
Terrestrial Sequestration Opportunities

- Largest terrestrial sequestration opportunity in each state is afforestation
- Changing forest management has limited potential
- Fire appears to be the most important management issue to address
- Forest conservation limited but some important opportunities
- Negligible opportunity for terrestrial sequestration from changing ag management

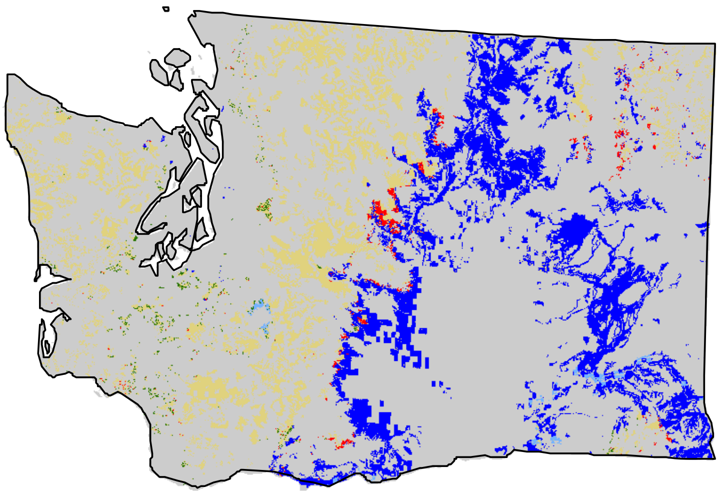
Results after 40 Years

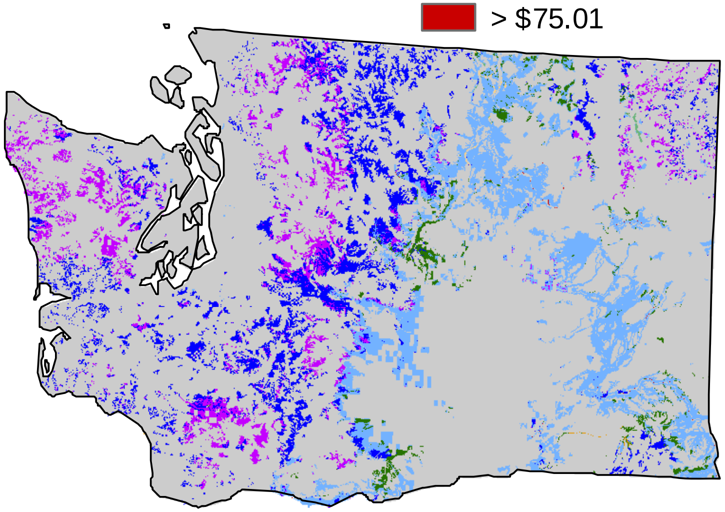
	California		Oregon		Washington	
	Area	Quantity	Area	Quantity	Area	Quantity
Grazing Lands—Afforestation	million acres	MMT CO_2	million acres	MMT CO_2	million acres	MMT CO_2
< \$2.40/metric ton CO_2	**3.61**	**1138**	**1.43**	**341**	**4.34**	**897**
< \$10/metric ton CO_2	**17.1**	**3228**	**16.86**	**1395**	**9.04**	**1217**
< \$20/metric ton CO_2	**20.1**	**3347**	**19.12**	**1476**	**9.08**	**1220**
Crop Lands—Afforestation						
< \$2.40/metric ton CO_2			**0**	**0**	**0.03**	**8**
< \$10/metric ton CO_2			**2.25**	**484**	**1.76**	**159**
< \$20/metric ton CO_2			**5.18**	**693**	**5.59**	**425**
Forests—Rotation Extension 5 yr extension, 20 yr contract						
< \$2.40/metric ton CO_2		**0**		**0**		**6.08**
< \$10/metric ton CO_2		**0**		**0.37**		**7.17**
< \$20/metric ton CO_2		**7.25**		**1.80**		**13.55**

Oregon: Potential Sequestration and Cost after 40 Years from Afforestation

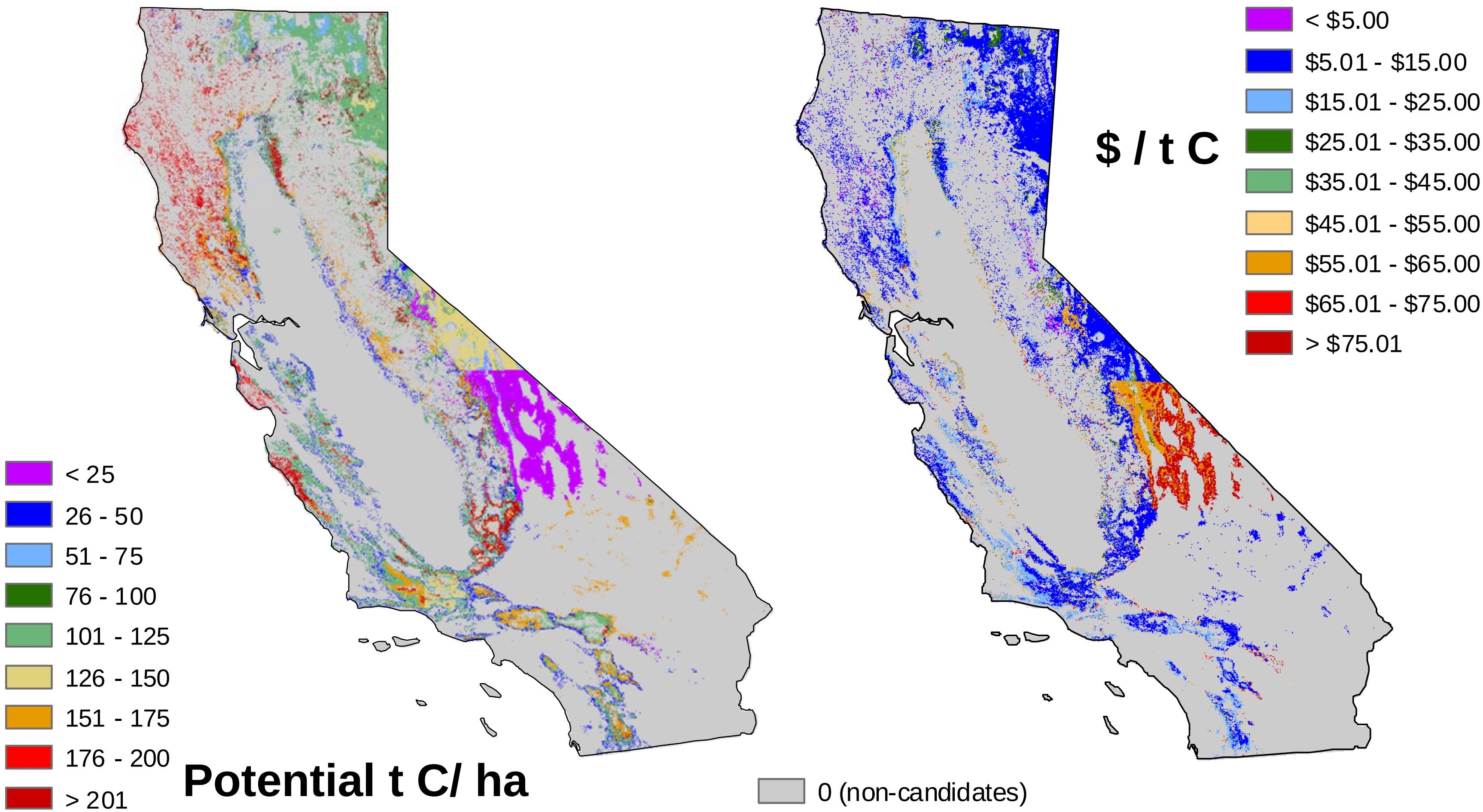


Potential Sequestration and Cost after 40 Years from Afforestation for Washington





Potential Sequestration and Cost after 40 Years from Afforestation for California



Forest Management Options to Increase Sequestration

- Allow timber to age before harvest (i.e., lengthen rotation time)
- Increase the riparian buffer zone by an additional 200 feet
- Reduce forest fuel load to reduce risk of uncharacteristically severe fires, with subsequent use of biomass in power plants

Extending Rotations

	Extending Rotations					
	Washington			Oregon		
	5 yr.	10 yr.	15 yr.	5 yr.	10 yr.	15 yr.
Private Land Potential Hectares	443,665			283,670		
Million Tons CO_2	18.7	33.0	44.0	13.2	23.1	30.8
Million $	$460	$894	$1,270	$394	$787	$1,150
Average $ per ton CO2	$30	$34	$37	$30	34	37
Average $ per acre	$419	$815	$1159	$562	$1123	$1641
Average Tons per acre	4.7	8.2	10.9	5.1	9.0	12.0
Public Land Potential Hectares[1]	147,625			36,368		
Million Tons CO_2	7.3	13.2	17.6	2.2	3.7	4.8
Million $	$203	$394	$564	$63	$129	$193
Average $ per ton CO_2	$30	$34	$37	$30	$34	$37
Average $ per acre	$558	$1082	$1547	$702	$1435	$2147
Average Tons per acre	5.6	9.8	13.1	6.2	11.1	14.9

[1] Note that public land omits federal USDA Forest Service lands.

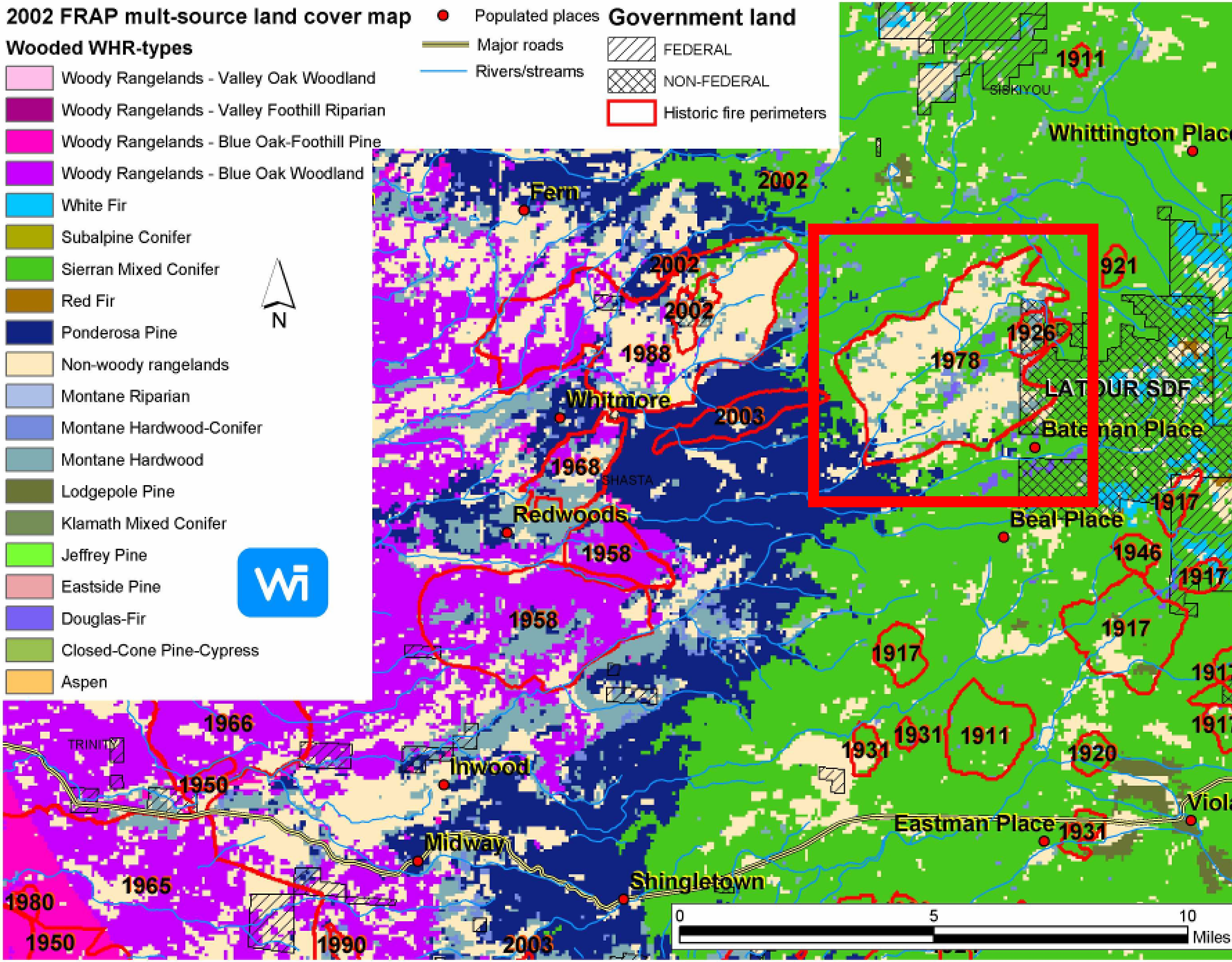
Riparian Zone Protection

	California	Oregon	Washington
Riparian stream length (thousand kilometers)	103.9	26.2	23.2
Total potential area (acres)	1,565,600	395,200	349,500
Mature potential area (acres)	116,100	20,700	34,800
Total carbon (million tons CO_2)	10.8	1.25	2.24
Average cost per ton ($/t CO_2)	$23	$40	$33

Potential Sequestration Benefits from Improved Fire Management

Source: Dr. Sam Sandberg, USDA Forest Service Pacific Wildland Fire Sciences Laboratory

- Reduce net GHG emissions from combustion
- Reduce loss of carbon stocks from large trees
- Reduce loss of carbon stocks from duff
- Maintain carbon accumulation rates during recovery
- Avoid ecosystem-changing fires



2002 FRAP mult-source land cover map
Wooded WHR-types
Woody Rangelands - Valley Oak Woodland
Woody Rangelands - Valley Foothill Riparian
Woody Rangelands - Blue Oak-Foothill Pine
Woody Rangelands - Blue Oak Woodland
White Fir
Subalpine Conifer
Sierran Mixed Conifer
Red Fir
Ponderosa Pine
Non-woody rangelands
Montane Riparian
Montane Hardwood-Conifer
Montane Hardwood
Lodgepole Pine
Klamath Mixed Conifer
Jeffrey Pine
Eastside Pine
Douglas-Fir
Closed-Cone Pine-Cypress
Aspen
Populated places
Major roads
Rivers/streams
Government land
FEDERAL
NON-FEDERAL
Historic fire perimeters
N
SISKIYOU
Whittington Place
Fern
Whitmore
SHASTA
Redwoods
LATOUR SDF
Bateman Place
Beal Place
Inwood
Midway
Shingletown
Eastman Place
Viola
TRINITY
1911
2002
921
1926
1978
1988
2003
1968
1917
1958
1946
1931
1920
1966
1950
1965
1980
1990
0
5
10
Miles

Ecosystem Conversion

Site of 1978 Whitmore fire in Latour State Forest, Shasta County

Fire can change forest ecosystems to non-forest ecosystems

Emissions Reductions by Changing Fire Management

	California	Oregon	Washington
Treatable Area (million acres)	**1.51**	**6.47**	**5.76**
Biomass (millions tons carbon)	**54**	**413**	**376**
Emissions assuming 10% loss (million tons CO_2e)	**19.8**	**151.6**	**138.0**
Emissions assuming 70% loss (million tons CO_2e)	**138.7**	**1,061**	**969**

Potential reductions in emissions from fire estimated by looking at forest lands at moderate to severe risk of fire on lands with <40% slope within 400 meters of existing roads and within 50 miles of biomass energy facility

Forest Conservation

Photo: Tim Pearson, Winrock International

- Stop forest conversion to non-forest
- Sierra Mixed Conifer (150 year old forest)
  - **575 tCO_2/acre**
- Redwood (150 year old forest)
  - **730 tCO_2/acre**

FLAT OF DOWN REDWOODS. Note man in lower right hand corner. (Photo Union Lumber Company Collection)

Planning for Pilot Projects

- Criteria for selecting pilot sites
- Project categories
  - Afforestation
  - Hazardous fuel reduction to reduce emissions from fire
  - Forest management and conservation

Why Shasta County?

- Diverse land cover representative of many areas across the state
- Opportunities for implementation of important classes of project opportunities
  - Afforestation
    - Rangelands
    - Riparian zones
  - Changes in forest management
    - Conservation
    - Reducing hazardous fuels
    - Lengthening rotations

Why Lake County?

- Selected for Oregon Solutions Project
- Opportunities for implementation of important classes of project opportunities
  - Changes in forest management
    - Reducing hazardous fuels
  - Afforestation
    - Hybrid poplar

Conclusions

- Largest terrestrial sequestration opportunity in each state is afforestation
- Fire appears to be the most important management issue to address
- Pilot projects developed for Shasta and Lake Counties
- Further characterization needed
  - Fire
  - Fast-growing species
  - Riparian zone restoration
  - Baselines for conservation
  - Identify additional pilots for Washington and Arizona